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The Subsidization of Innovation Projects by the Government of Canada

Abraham Tarasofsky

A native of Montreal, he is a senior economist at the Economic Council of Canada. His doctorate is from McGill University, and he is also a Chartered Accountant. He was a member of the research staff of the Carter Royal Commission on Taxation and taught at Concordia University. He is the author of studies in the fields of taxation, public sector economics, inflation accounting, and the economics of technological change.

ABRAHAM TARASOFSKY

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Introduction

This study, which forms part of the research undertaken in connection with the Economic Council's recent consensus document entitled *The Bottom Line*, is concerned with one aspect of a wider question that continues to be the subject of much discussion: How can the Government of Canada best promote more research and development (R&D) spending by the private sector? The objective of promoting R&D is one that Canada shares with many other industrialized countries, and most of the devices adopted towards that end in this country are similar in nature, if not in scale, to those adopted elsewhere. They include the research undertaken in facilities operated, or sponsored, by the government; government procurement activities (not so defence-oriented in Canada as in some of the other countries), and various tax incentives to firms. Of these, the last is quantitatively the most important. One additional device used to promote R&D in Canada has relatively few counterparts in other comparable countries – namely, the payment of direct subsidies to firms undertaking specific innovation projects.

It is this particular means of fostering private R&D activity that is the subject of this study. Five federal subsidy programs are examined – four in considerable detail and one (the smallest, which does not involve cash transfers) only cursorily. They are: the Enterprise Development Program (EDP), the Defence Industry Productivity Program (DIPP), the Industrial Research Activities Program (IRAP), the Program for Industry/Laboratory Projects (PILP), and the Technical Information Service (TIS). The first two are operated under the aegis of the Department of Industry, Trade and Commerce;[1] the others, under the aegis of the National Research Council.

Although two of these programs have thrice collectively received published, independent analytical attention [Howe and McFetridge (1976), McFetridge (1977), and Hewitt (1981)], the others have apparently not been studied. The primary purpose, on the first and third occasions, was to identify the determinants, including subsidies, of private R&D spending. The primary purpose on the second occasion, which built upon the previous exercise, was broader: to investigate the very rationale for this species of subsidization. The present study draws importantly upon the second exercise, but it also extends its analysis in a number of respects. We begin by addressing, along McFetridge's lines and in his terms, the fundamental question: Why subsidize private R&D? The answer to this question is not apparent at first blush. Private firms exist, after all, in order to earn profits – assumedly maximum profits – for their owners. The undertaking of innovative activity, of which spending on R&D is a prime example, is a major means to that end. Why, then, should private entrepreneurs be endowed, through government action, with unilateral transfers of society's resources to enable them to pursue their own interests – a pursuit that presumably is, or should be, their main activity?

Put so broadly (and, admittedly, rather tendentiously), the question tends to provoke an immediate and negative reaction. But if, while retaining its essence, the question is reformulated to ask under what conditions, if any, the subsidization of private R&D projects is legitimate, there is a distinctly less negative, though qualified, response. It emerges that there could indeed exist, under quite common institutional arrangements, circumstances in which R&D projects that would ultimately serve society's interests would not be undertaken without special government measures, for the very good reason that it would not be in the interests of any firm to undertake them. In other words, situations do exist where the interests of society are at variance with those of firms; in such cases, unless assisted, firms will not willingly undertake certain projects. Society is then the loser. This, in itself, is hardly a new insight. It goes back at least as far as the emergence of patents. These are monopolistic devices made available to encourage innovators in their risky pursuits; they empower them to garner a greater share of the fruits of success than would otherwise be theirs in a competitive world. Patents, however, can only ameliorate the problem, they cannot solve it. They are only granted for a certain term; moreover, the royalties that they enable their owners to charge prevent the prices of innovative products from falling to socially optimal levels. In principle, therefore, something more – namely, a subsidy – is needed if all R&D projects that are in the social interest are to be encouraged and undertaken.

All of this has been carefully derived from first principles by McFetridge and his antecedents, and, as will be seen, it goes far to justify the existence, *in*

principle, of project-specific subsidy programs of the type represented by most of the programs under review. It does not, however, go the whole conceptual distance. As will be shown, this earlier work serves more to establish the necessary, rather than the sufficient, conditions for project-specific subsidies. The further conditions must therefore be developed. Furthermore, the previous work implies that no distinction should be made between for-export innovations and those whose ultimate products are mostly consumed domestically. As will be shown later, however, matters become quite problematic when a project is export-oriented; this issue goes right to the heart of the *raison d'être* of one of the largest of the programs being reviewed. The first major objective of this study is therefore to contribute a more definitive analysis of the rationale for project-specific R&D subsidies when the prospective product is mainly for domestic consumption.

Establishing that such project-specific subsidy programs can have a valid theoretical justification, however, does nothing in itself to validate the performance of any given program. Such an inquiry would constitute a further, and quite distinct, exercise. The specification and performance of that additional exercise, with respect to these particular programs, is the other major purpose of this study.

Before that task can be undertaken, however, something more needs to be done. It must be established that, apart from their theoretical justification, such programs are in fact practical propositions. In other words, can the necessary information be generated, and can calculations be made as to whether a subsidy for a given project is necessary and warranted, both without undue cost or difficulty? The implications of these questions are examined, and they are ultimately answered in the affirmative.

With this discussion and the above-mentioned theoretical rationale serving as a frame of reference, each of the four programs is examined in its own terms, so to speak, as an administrative organism. In effect, the following questions are asked:

1) What does the program seek to accomplish; in other words, what are its objectives?

2) How is the program administered in pursuit of these objectives? Specifically:

a) What are the criteria that proposed projects must meet in order to qualify for subsidies?

b) What is the program's decision-making process?

c) What is the informational basis for the decisions to award or deny subsidies to proposed projects?

The foregoing questions, raised in the context just described, are intended to determine whether and, if so, to what extent the terms under which each program was originally conceived and the manner in which it has been operated thus far conform to the requirements of sound *a priori* decision making. That is to say their purpose is to ascertain whether the mandate assigned to each program's administrators and the rules and procedures that they have adopted are such that they will enable those administrators to award subsidies only to reasonably needy and deserving projects and to pay only the minimum required in each case.

Vital though it is, sound *a priori* decision making is not enough to ensure that a given subsidy program will be efficient, as well as effective. All R&D projects are inherently risky, and the prospective calculations necessary for sound subsidization judgments involve peering into the future – almost invariably over a horizon extending for 5 to 10 years or thereabouts. This kind of uncertainty is generally bound to produce outcomes that deviate from what was initially expected (sometimes for the better, sometimes for the worse) and not infrequently by a wide margin. It is therefore essential that the administration of a subsidy program incorporate appropriate mechanisms for self-evaluation. Without them, lessons cannot be learned from past errors, and procedural rectifications cannot be made. As before, establishing the concept in principle is one thing, making it workable another. This task forms another phase of the exercise.

To sum up, this study analyses (to a more definitive degree than previous work has done) the theoretical justification for project-specific subsidy programs. It then scrutinizes the workings of several such programs of the Government of Canada, on the basis of that justification, to determine whether they have been operating in an appropriate fashion and, if not, to indicate how they might be improved. As far as can be determined, this latter exercise has seldom, if ever, been done before. That endows the study with most of its other claims to originality.

Chapter 1 is of pivotal importance. There, after closely retracing a number of McFetridge's steps, the conceptual rationale for subsidizing specific R&D projects (of mainly domestic orientation) is developed in its entirety, and various practical questions pertaining to the administrative expression of that rationale are explored. The theoretical and practical issues that arise in the retrospective evaluation of project-specific subsidy programs are then considered. Chapter 2 is concerned with the Enterprise Development Program. It begins, however, by referring to two of its predecessor programs (one in particular), partly to give the Program's background and partly because this predecessor represents a cautionary tale in its own right. The pioneering work of Howe and McFetridge is further drawn upon, with respect to the Program, in an econometric attempt to estimate its

impact upon the autonomous R&D spending of subsidized firms. The Defence Industry Productivity Program is the subject of Chapter 3. This chapter has two distinct parts (unlike the other two chapters concerned with specific programs, which are more of a piece). The reason for this unusual structure is that the mandate of this particular program is uniquely oriented towards innovations for export – albeit innovations pertaining to defence production. (The mandates of the other programs reviewed are all neutral with respect to whether innovations are for foreign or domestic consumption.) The first part of the chapter addresses the implications of this orientation (in a fashion that may be original in some respects) and concludes by making a case for changing the Program's focus from the project to the firm. The second part examines the Program along lines that are compatible with those relating to the other programs – in effect, as though the caveats developed in the first part did not apply. The fourth chapter discusses successively the three smaller programs administered by the National Research Council. The study concludes with a brief summary chapter.

1 Project-Specific Government Subsidization of Industrial R&D: Rationale and Practicalities

Firms undertake innovative projects, such as spending on research and development, in the hope of enhancing their profits through stealing a march on their competitors by being the first to introduce a new or improved product, or method of production. That being so and the pursuit of profits being the preeminent *raison d'être* of firms, it might reasonably be thought that firms proposing to undertake R&D projects should have no particular claim on government financial support or, at most, that they should have no greater claim than any other economic agent bent upon promoting his own interests. The reasons why such a view would be inadequate, in spite of an apparent plausibility, can be approached, as was suggested earlier, by putting the issue somewhat more positively. Are there any circumstances in which it is justifiable for the government to subsidize a firm undertaking R&D activity – an activity that is presumably in its own interests and one that, as a profit-seeking entity, it is, or should be, intrinsically predisposed to undertake? Or is this notion as to the relationship between R&D activity and the firm's interests too sweeping? Is it conceivable, for example, that certain R&D projects could be in society's interests but yet not in the firm's, in which case the firm would have to be induced, by means of devices such as subsidies, to undertake them?

That these questions, especially the last two, are capable, in principle, of being answered in the affirmative will be shown below by considering some of the relationships governing innovations that obtain, under commonplace institutional and market conditions, between the inappropriable social returns to innovations on the one hand and the private returns and costs on the other. A basic principle is then derived from these relationships to serve as a minimum conceptual test for the validity and extent of a subsidy to a private entrepreneur contemplating a given innovative activity. This principle has two essential features: the subsidy must suffice to offset any excess of the project's private costs over its private benefits, but it must itself be exceeded by an accompanying surplus of inappropriable benefits over private benefits from the project. These conditions, however, are not sufficient to justify government subsidization of the project; hence the various additional requirements are developed systematically. It is recognized that the introduction of considerations such as inappropriable benefits raises practical issues of critical importance to the formulation of subsidization policy and its administration. This is because, whereas private benefits and costs tend to be reasonably identifiable and measurable, their inappropriable counterparts are more elusive – in both their qualitative and quantitative aspects, especially the latter. The practical exigencies presented by these problems and the various approaches for dealing with them are therefore considered in detail.

Fundamentally, this chapter is concerned with the issue of "incrementality" in its various aspects – that is, the question of the degree to which the subsidized project represents a net increase, first, in R&D spending by the subsidized firm and within the industry to which it belongs and, finally, in total welfare within the economy as a whole. The quite different factors that pertain to each of these three contexts – where the absence of incrementality in the second or third is sufficient to negate its presence in the preceding ones – are discussed in turn.

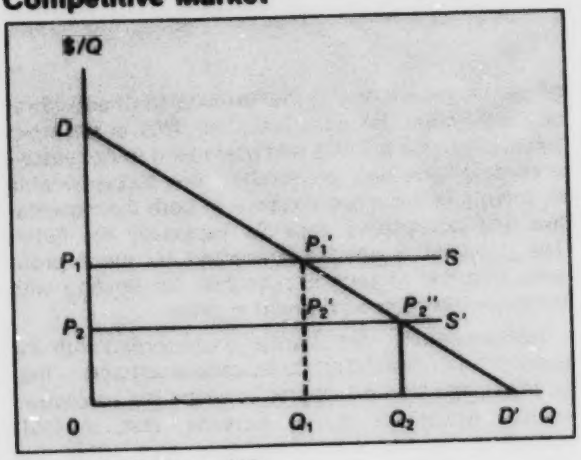
The Conceptual Rationale and a Few Practicalities

McFetridge presents the following model, which has antecedents in the work of Griliches (1958), Nordhaus (1967), and Scherer (1972).[1] His analysis, reproduced below, enables us to examine some implications of the creation of new knowledge by a firm in a competitive industry, in the form of, say, a cost-reducing-process innovation. (The analysis appropriate to a product innovation is logically equivalent.) The situation in the market in which the firm operates is shown in Figure 1-1.[2]

Because of the competitive nature of the industry, all of its member firms are able to adopt the new process for producing commodity X without compensating the innovative firm. This causes the industry's long-run supply curve to shift downward to S', the market price of X to fall to P_2, and its total output to increase to Q_2. The per-period gain to society is represented by area $P_1P_2P_2''P_1'$, which equals the consumers' surplus resulting from the innovation. Letting $\dot{C}$ be the percentage reduction in the price of X as a result of the innovation and ϵ the absolute value of the elasticity of demand for X at price P_1, for small values of $\dot{C}$ the present value of the total (social) benefits flowing from the innovation can be written as

Figure 1-1

Effects of a Process Innovation in a Competitive Market



SOURCE McFetridge (1977).

$$W = [P_1 Q_1 \dot{C} + \frac{1}{2}\epsilon P_1 Q_1 \dot{C}^2]/r, \quad (1)$$

where r is the discount rate of the flow of total benefits, which is assumed to be perpetual.

Differentiating Equation (1) with respect to $\dot{C}$ gives W', the present value of the marginal total benefits resulting from an increase in the rate of cost reduction. W' is an increasing function of $\dot{C}$ and is written as

$$W' = P_1 Q_1 (1+\epsilon\dot{C})/r. \quad (2)$$

It is now assumed that the $\dot{C}$ is an increasing function of the volume of resources (whose value is denoted by R) committed to R&D in this area. Thus

$$\dot{C} = f(R) \quad f' > 0. \quad (3)$$

The resulting inverse relationship,

$$R = g(\dot{C}) \quad g' > 0, \quad (4)$$

implies that R is an increasing function of the desired rate of cost reduction. It is also assumed that the costs of successive increases in $\dot{C}$ are themselves increasing, thereby giving g' a slope that is positive and increasing. There is also the implicit assumption that the firm in question is alone in making R&D outlays pursuant to this particular innovation; hence, its private costs also represent the whole of society's costs.

To maximize the present value of the net social benefits of the cost reduction is to maximize

$$W - g(\dot{C}),$$

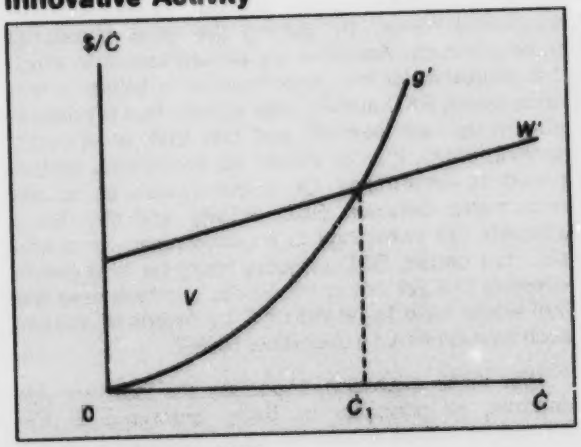
which implies that

$$W' = g'(\dot{C}).$$

This equality is shown in Figure 1-2. It occurs when a rate of cost reduction equal to $\dot{C}_1$ is attained, which in turn yields net social benefits equal to area V.

Figure 1-2

Maximization of the Net Social Benefits of Innovative Activity



SOURCE McFetridge (1977).

The most striking feature of the socially optimal rate of cost reduction $\dot{C}_1$ is that, given our assumptions, there is no reason why it should ever emerge. The problem is that the innovative firm, which has devoted resources to developing this form of cost reduction, has no enforceable property right to it. The innovation is freely available at zero price to every producer of X. Hence, the innovator receives no return on his R&D outlays; and, since he knows this in advance, he will refrain from making them. In other words, the innovative activity will not take place and the loss to society will equal area V.

In reality, of course, innovators often do have property rights to their innovations in the form of patents. The significance of this consideration in the present context depends heavily upon the legal life of

the patent. Consider a patent of unlimited duration. The innovator-patentee, having at his disposal an innovation that enables users to produce X at a per-unit cost saving of $P_1 - P_2$ per period (in terms of Figure 1-1), is in a position to charge these users a maximum per-unit royalty of slightly less than $P_1 - P_2$. His total royalty income per period is very close to area $P_1P_2P_2'P_1'$ and since the price remains at P_1, this also represents the total benefits produced per period by the innovation. In this situation, the total benefits, which have a present value of $I = (P_1Q_1\dot{C})/r$, are less than the maximum social benefits given in Equation (1) above. (The difference, whose present value is $(\frac{1}{2}\epsilon P_1Q_1\dot{C})/r$, represents the consumers' surplus on the forgone production of X – namely, Q_2Q_1.) Moreover, they also accrue almost entirely to the innovator, thus becoming private benefits. Since the I' function must also lie below the W' function in Figure 1-2, the resulting equilibrium rate of cost reduction will be less than $\dot{C}_1$; and the net social benefits, less than area V.

This situation suggests two alternative ways of closing the gap. One alternative would be for the government itself to undertake the R&D activity necessary to accomplish the socially optimal rate of cost reduction $(\dot{C}_1)$ and then make the results available free to all producers of X. The other alternative would be to grant the innovative firm, in addition to a patent of unlimited life, the right to engage in unrestricted price discrimination between its customers. The distributional implications of these alternatives would, of course, be very different indeed. In the former case all the benefits would accrue to the consumers of X; in the latter, they would accrue to the innovative firm. But the results would be the same in terms of efficiency: a rate of cost reduction equal to $\dot{C}_1$ would take place, and the net benefits would equal area V.

Even if efficiency is the watchword, however, it is difficult to say *a priori* which of these two alternatives is to be preferred, since administering either one will involve costs. If the government undertakes the R&D, it does not necessarily mean that the officials responsible for performing it and for disseminating its results will voluntarily choose resource allocations that maximize net social benefits.[3] Hence costs must be incurred to ensure that they do. Similarly, the price-discriminating patentee must incur costs to enforce his rights and operate his pricing mechanism. It is an open question as to which of these costs are the greater.

The foregoing discussion leaves no room for partial subsidization by the government of private R&D: either the government makes the total outlay or it makes none of it. But if a situation is contemplated in which the innovative firm is able to appropriate *part* of the returns from the innovation (instead of all or none), partial subsidization becomes justifiable.

Partial appropriability of benefits by an innovator results from his possessing less than complete property rights to his innovation. This occurs, for example, when he is granted a patent with a fixed life and when he is prohibited (as he is generally prohibited in reality) from engaging in price discrimination. Given a patent with life T, the present value of the flow of the patentee's royalty income of $P_1Q_1\dot{C}$ per period that results from the innovation is

$$G = (P_1Q_1/r)(1-e^{-rT})\dot{C}, \tag{5}$$

and the present value of the flow of total benefits is

$$B = (P_1Q_1/r)\dot{C} + (\epsilon P_1Q_1e^{-rT}/2r)\dot{C}^2. \tag{6}$$[4]

Differentiating Equations (1), (5), and (6) with respect to $\dot{C}$ to obtain the present-value changes in a) the maximum conceivable total benefits, with no patent; b) the attainable total benefits, given a patent; and c) the patentee's private benefits, respectively, gives

$$W' = P_1Q_1/r + (P_1Q_1\epsilon/r)\dot{C}; \tag{7}$$

$$B' = P_1Q_1/r + (\epsilon P_1Q_1e^{-rT}/r)\dot{C}; \text{ and} \tag{8}$$

$$G' = (P_1Q_1/r)(1-e^{-rT}). \tag{9}$$

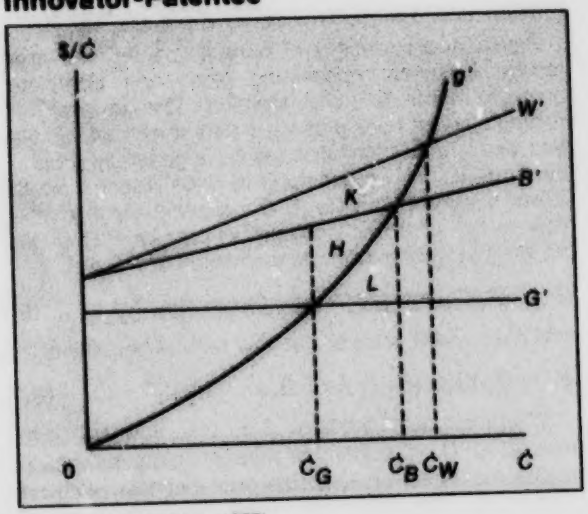
These three equations, together with g', the derivative of Equation (4), are plotted in Figure 1-3.

The private benefits to the innovator-patentee will be maximized when the rate of cost reduction equals $\dot{C}_G$. Since B' lies everywhere above G', however, this rate of cost reduction fails to maximize total benefits, given the patent. To accomplish this maximum, a rate of cost reduction equaling $\dot{C}_B$ would be necessary. Moreover, since W' lies everywhere above B', the rate of cost reduction represented by $\dot{C}_G$ falls short, *a fortiori*, of the rate of cost reduction (equal to $\dot{C}_W$, which corresponds to the maximum total benefits, given the absence of a patent.

This situation implies the possibility that the payment of a government subsidy to the innovative firm will serve society's interests by producing social benefits greater than the subsidy. Consider the situation depicted in Figure 1-3. Left to itself, the innovative firm will spend just enough on R&D to produce a rate of cost reduction equal to $\dot{C}_G$, and no more. The socially optimal rate of cost reduction, given that the firm has a patent namely, $(\dot{C}_B)$ is

Figure 1-3

Effects of Subsidizing an Innovator-Patentee



SOURCE McFetridge (1977).

unattainable, since the firm will not choose to incur the costs of further cost reduction when these exceed the extra private benefits that it can derive therefrom. This state of affairs involves a welfare loss to society that can only be remedied by government action, if at all. If the government were to pay the innovative firm a subsidy equal to area *L*, the firm would be motivated to proceed to a rate of cost reduction equal to $\dot{C}_B$. The present value of the *net* additional benefits attributable to the subsidy is equal to area *H*.

It is noteworthy, however, that, given "ordinary" patent rights, this subsidy will not suffice to summon forth the innovative effort required to accomplish $\dot{C}_W$ – the maximum rate of voluntary cost reduction that is rationally conceivable. (Beyond that rate, the costs of additional units of cost reduction exceed the additional benefits that they produce under all institutional arrangements.) The problem resides in the patent rights. Because the patentee is able to collect a royalty per unit of commodity *X* verging on $P_1 - P_2$, the price of *X* remains at P_1. This causes a loss of benefits, having a present value equal to area *K* – the consumers' surplus that would have emerged if the price of *X* had fallen to P_2. (Area *K* should, however, be regarded as second-order relative to the area encompassed between *B'* and *G'*.)

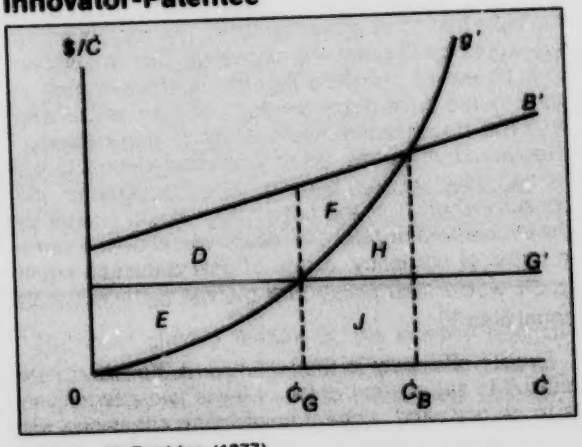
As before, there are only two ways in which the maximum total benefits associated with a rate of cost reduction equal to $\dot{C}_W$ could be achieved. One way would be to make the life of the patent unlimited while allowing the innovator-patentee to engage in price discrimination. The other way would be for the government to undertake, or subsidize, the entire innovative effort and then make the results available free to all producers of *X*. If, as does not seem unlikely, the social costs of these alternatives are not significantly different (this question, however, being empirical, has not been explored), the issue must turn on other considerations. One of these must surely be the undesirable distributional implications of endowing any producer of a commodity with the powers of a price-discriminating monopolist, to say nothing of granting him a patent of unlimited duration.

The Nationality of the Entrepreneur

Should differences in the nationalities of private entrepreneurs matter to the government when it allocates subsidies to private R&D projects?[5] Drawing upon Equations (1), (3), (4), (5), (6), (8), and (9) above, some of the relations that enable us to consider this question are shown in Figure 1-4.

Figure 1-4

Implications of the Nationality of an Innovator-Patentee



SOURCE McFetridge (1977).

Once again, an entrepreneur holding a patent with a given life will maximize his net private benefits attributable to R&D by choosing a rate of cost reduction equal to $\dot{C}_G$. The present value of the net private benefits is represented by area *E*. The present value of the net total (i.e., Canadian) benefits resulting from this situation is affected substantially by the nationalities of the shareholders of the innovative firm. If, at one extreme, they are all Canadians, the

present value of the net total benefits is given by the sum of areas *E* and *D*. If, at the other extreme, they are all foreigners, area *E* becomes a cost to Canada, since the resources that it represents will ultimately be lost to Canada. Thus only area *D* remains as the net domestic social benefit. Any increase in the patent life would cause area *D* to shrink. This implies that the longer the patent term, the greater the cost to Canada of foreign ownership. On the other hand, the existence of income taxes reduces the cost to Canada of foreign ownership. The higher the rate of taxation, the lower the cost.

Matters become somewhat more complicated when government subsidies to foster R&D are introduced into this model. As before, the subsidy, now denoted by area *H*, will serve to increase the rate of cost reduction to $\dot{C}_B$ and thereby maximize the present value of net total benefits. It will increase these net benefits beyond their presubsidy level by an amount equal to area *F*. But this last result is independent of the nationalities of the shareholders of the innovative firm. Since the additional net benefits are not privately appropriable, it is of no consequence whether the shareholders are Canadians or foreigners.

This does not mean, however, that the nationalities of the shareholders of an innovative firm should be a matter of indifference to the government officials responsible for administering subsidy programs. There are various conceptual conditions that must be met if subsidies in support of R&D and the like are to be considered consistent with economic efficiency and equity. Among these are two related aspects, each of which might be termed a minimum condition, a kind of *sine qua non*, which, if not satisfied, tends to render the subsidy unwarranted or at least excessive. They will be presented forthwith. It is not easy to determine whether and, if so, to what extent either of these conceptual conditions is likely to be met by any prospective subsidy recipient. So it would not be difficult for program administrators, operating with the best of intentions, to violate these conditions, *inter alia*, and give unwarranted or excessive subsidies to some firms. When these firms are controlled by foreigners the loss to the Canadian economy is greater than it would have been had they been controlled by Canadians.

Some Minimum Conditions

The main issue can now be approached. Although the foregoing model is formulated on the basis of continuous functions and in terms of a process innovation, its implications can readily be extended to discrete R&D projects, which could involve either process or product innovations; and the latter could be either new products or improved versions of existing ones. Converting the same notation to the discrete case implies that the optimal subsidy *S* is such that

$$g' - G' = S \leqslant B' - G', \tag{10}$$

where g' = the project's R&D costs;
G' = the present value of the project's private benefits; and
B' = the present value of the project's total benefits.

Ideally, then, the subsidy must, according to McFetridge, satisfy two conditions. First, it must be equal to the excess of the present value of the innovator's R&D costs over the present value of his private benefits. Second, it must not exceed the project's inappropriable benefits: the excess of the present value of its total benefits over that of its private benefits. These two conditions derive from the fact that, in order to make awards that are likely to leave society better off than before, program administrators must learn to navigate between the Scylla of the project that does not require a subsidy in order to go forward (its net private returns are positive) and the Charybdis of the project that does not deserve a subsidy (its inappropriable returns are inadequate). Strictly speaking, a subsidy that met the second condition but exceeded the firm's private deficit might still serve society's interests, though it would do so only in efficiency terms. There would be equity costs. But since the purpose of this study is to promote both the most efficient and the most equitable subsidization policies attainable, it seems best to couch the relevant criteria in stringent terms.

Vitally important though they are, McFetridge's conditions are, however, insufficient to establish whether a given project truly merits subsidization. Together they constitute an initial hurdle that projects proposed for subsidization must overcome – one capable of screening out the obvious nonstarters but incapable of permitting a definitive judgment about the survivors. This is because their focus is entirely upon the project, and such a focus cannot suffice. It cannot suffice because the payment of a subsidy is a transfer of resources – a transfer to the recipient firm that was extracted from other economic agents. This extraction must be taken into account, as shown in Equation (10), in judging the validity of the contemplated subsidy, but so must the fact that the very *process* by which the resource transfer is effected itself consumes resources. These costs must also be reckoned with. *S* is therefore not the optimal subsidy. The relation in Equation (10) must be regarded as specifying certain, though not all, of the conditions

that subsidized projects must meet. The remaining conditions will be developed shortly.

McFetridge also proposes various practical guidelines to assist program administrators whose task it is to evaluate firms' requests for innovation subsidies. It should, according to him, be a primary requirement that applicants provide:

(a) estimates of both the project's costs and its expected stream of returns, net of project costs; and

(b) estimates of the benefits to others of the project's results, together with estimates of the extent to which the applicant can require those others to compensate him for these benefits.

He recognizes that the applicant has an incentive to understate the project's private benefits and to overstate its total benefits. The applicant, in other words, has an incentive not only to overstate the benefits others will receive from the project but also to understate the extent to which they can be required to pay for them. It is the program administrator's difficult task to resist these biases on the part of applicants and develop the true picture.

Another important question that the program administrator must resolve is which discount rate to apply to the project's costs and benefits in order to determine their present values. McFetridge holds firmly that market rates should apply. He suggests, for example, that the price/earnings ratio of the applicant's shares or the price/earnings ratios of the shares of firms in similar environments would be an appropriate means of inferring the correct market rate. But this insistence upon a total reliance on market rates of discount, however computed, may be excessive. Quite apart from the income tax considerations raised by Mayshar (1977) – which would make the government a partner in all private projects – the subsidy, without which presumably the project would not be undertaken, constitutes a certain proportion of the project's total R&D costs. A corresponding proportion of the project's streams of private and inappropriable benefits is therefore attributable to the subsidy. Thus it may be appropriate for that proportion of the benefits to be discounted at a rate that, if not riskless, is subject to a lower risk premium than the market rate. Given risk-sharing with respect to government outlays, the more widely distributed the project's benefits, the lower (it has been suggested) would be the appropriate risk premium. This approach implies that a blended discount rate might be appropriate to the streams of benefits emanating from subsidized projects – the blend reflecting the relative outlays from the private and public purses. The question of the appropriate discount rate cannot, therefore, be resolved in isolation from the wider question of whether publicly funded projects should be subject to the same risk premium to which privately funded projects are subject. This question is discussed later in Appendix A.

There is yet another important issue to be foreshadowed. It concerns the respective time horizons over which the product's flows of private and inappropriable benefits should be estimated and discounted. Although it was not essential to the argument, the foregoing analysis tended to imply that these two horizons are identical. As is explained later in this chapter, however, there is no particular reason why this should be the case in any given situation, because these horizons depend upon different factors. The implications of this highly probable inequality for program administrators are considered at the same time.

A Paradoxical Feature

McFetridge also draws attention to an interesting, paradoxical feature that could arise from the payment of subsidies calculated as a predetermined portion of total project costs. This feature will assume potential importance when we consider the specific government programs under review. Dividing Equation (10) above, which defines (for the moment) the optimal subsidy, by g' gives

$$(g' - G')/g' = S/g' \leq (B' - G')/g'. \qquad (11)$$

Clearly, the lower the value of G', the more closely will the left-hand and centre terms approach unity. In other words – as long as $B'/g > 1$ – the lower the private benefits, the higher must be the proportion that the subsidy bears to total project costs in order to induce the entrepreneur to undertake the project. Assuming that $B'/g > 1$ and disregarding the right-hand term, Equation (11) then gives, after rearranging terms:

$$G'/g' = 1 - S/g' = \Delta. \qquad (12)$$

Δ represents the proportion of the project's costs borne by the entrepreneur. It is evident from this relation that no project will proceed for which $G' \leq \Delta g'$. Δ, however, depends upon the size of the subsidy. Thus if S has an imposed maximum of, say, $.5g'$, this implies that no project will proceed for which $G' < .5g'$, no matter how great the project's inappropriable benefits ($B' - G'$) might be.

Yet, as McFetridge rightly emphasizes, it is precisely this excess of inappropriable benefits over project costs that justifies the subsidy; the greater the excess, the greater the justification! Hence there is a distinct possibility that the arbitrary imposition by the subsidy-granting authorities of a maximum subsidy/cost ratio will produce the unintended result of precluding certain projects that are in society's

interest, perhaps very much so. This type of reasoning can be extended to establish the inappropriateness of *any* arbitrarily imposed maximum subsidy, whether expressed as a proportion of project costs or of any other variable.

It is now also possible to explain more fully the above-mentioned possibility that an excessive subsidy to a foreign-controlled firm will involve a greater loss to the Canadian economy than if the firm were Canadian-controlled. As has been shown, the subsidy should equal the present value of the excess of project costs over private benefits. A subsidy larger than this amount to a foreign-controlled firm would result in a greater loss to the Canadian economy than would occur if the same subsidy were provided to a Canadian-controlled firm. The practical implication of this caveat is that applications from foreign-controlled firms should receive even closer scrutiny than those from Canadian-controlled firms, but – and this must be emphasized – the caveat is not in itself a reason for program administrators to discriminate between applicants in favour of Canadian-controlled firms.

Incrementality to the Industry

It is reasonable to assume that if a project is fully incremental to the subsidized firm – i.e., if the left-hand condition in Equation (10) above obtains – then, generally speaking, the project is also incremental to the industry to which the firm belongs. It does not seem likely that there are many projects that could involve a private deficit for one firm (the applicant for a subsidy) that would also be concurrently and profitably undertaken by one or more of its competitors and that would be duplicated or pre-empted if pursued by it on a subsidized basis. This generality, however, cannot absolve program administrators from the responsibility of keeping abreast of the main R&D trends and directions in at least the more important of the various Canadian industrial sectors. Given the concentration ratios of most industries, together with the fact that the number of firms that engage in large-scale R&D activity in any industry is usually small (and often very small), this constitutes a much less onerous burden than is apparent at first glance. There is little need, and less justification, for program administrators to try and ferret out the innermost secrets of the relevant firms in order to determine whether the project before them will duplicate or pre-empt a more efficient, competing project in another firm. Quite apart from the fact that, as is indicated in the research (discussed below) by Mansfield *et al.* (1977), – firms usually tend to have a fairly good, if only general, idea of what their main competitors are up to in terms of R&D activities, professionals in given fields communicate and exchange ideas with one another in a variety of forums. All of these considerations cannot, of course, preclude the possibility that a particular subsidized project – especially one in a narrow area – will not duplicate or pre-empt an unsubsidized, competing one; but they do serve to reduce that contingency to tolerable proportions.

Incrementality to the Economy

It was argued above that a subsidized project is incremental *to the firm* if the subsidy is the *sine qua non* of the firm's undertaking the project and *to the industry* if the project does not duplicate or pre-empt an equivalent project by another firm. It was also argued (to put it negatively) that no such subsidized project could be in society's interests unless it were also characterized by inappropriable social benefits with a present value in excess of the subsidy. Indispensable though these conditions are, they do not suffice, when met, to ensure that a given subsidy will in fact serve society's interests.

Whenever the government, in the course of operating a program of innovation subsidies (financed, say, by a tax on personal income),[6] subsidizes a given project, it shifts resources among economic agents. This not only alters the state of the economy; but, as was suggested above, it also consumes resources in its own right. Only after the various costs that this process entails have been identified and measured, and then set against the inappropriable benefits generated by the subsidized project, can a judgment be made as to whether society will be rendered better off. The immediate question concerns the cost factors involved in the tax-subsidy transfer and their magnitude.

The Costs of Paying Subsidies

Consider, first, the operating costs of a subsidy program. As one of the very few writers who has addressed the subject of these costs systematically, in anything resembling a Canadian context, Usher (1982) points out [p. 59]:

> "... It is customary in assessing the pros and cons of transfers to overlook the cost of moving money about and to analyze programs as though the only consideration... is whether a given dollar of expenditure is more beneficial in the hands of the recipient of the grant than it would be in the hands of a typical taxpayer. What tends to be overlooked when one reasons in this way is that the transfer is never one to one. Each dollar that finds its way by subsidy into the hands of the recipient firm costs the taxpayer something in excess of one dollar...."

This "something" represents no trivial amount, as will be seen shortly. Its components include the following:

a) The costs incurred by Parliament and the various governmental bodies involved in conceiving and planning the subsidy program, and, much more importantly, the costs incurred by the government department responsible for operating the program. These include the costs of processing the applications that are not accepted as well as those that are.[7]

b) The costs incurred by applicant firms in formulating and advocating their applications, irrespective of whether the applications are accepted.

c) The costs incurred by the economy when taxpayers rearrange their economic activities in response to the tax – for example, the cost of determining their tax liabilities and the so-called "deadweight" loss resulting from the tax.

However difficult they may be to estimate in practice, especially in the marginal terms that are theoretically correct, the nature of the costs in a) and b) is fairly (though not entirely, as will be seen below) self-evident. The item c) is less self-explanatory and should be explained briefly. The effect of an income tax upon an individual goes beyond the immediate reduction in his disposable income: it also extends to the various changes in his behaviour that occur under the impact of the tax. To begin with, a great many taxpayers need professional help in working out and minimizing their tax liabilities. Also, the fact that their after-tax income is, by definition, lower than their before-tax income implies that their behaviour, both as suppliers of labour and as consumers, is less advantageous to society than it would have been in the absence of the tax. This study is not the place for an extended discussion of the various conceptual and empirical issues that have emerged, and continue to emerge, in the literature pertaining to the deadweight costs of taxes. For that, the reader might consult Usher and the various references cited therein. One feature of these costs is worth noting here, however – namely, the possibility that the marginal deadweight costs associated with a small tax increase can be quite large even though the proportion of the total tax bill represented by total deadweight costs is relatively small. This has obvious potential significance in the present context, where the tax increases associated with the financing of subsidy programs are bound to be very small.

Usher estimates that the cost to taxpayers of income tax compliance, per dollar of tax paid, is 5.7 cents.[8] The marginal deadweight costs of the tax are certainly much greater than this amount, but the evidence available as to their order of magnitude is also highly problematic at this stage. Various estimates reported by Usher (most pertaining to economies other than the Canadian) range from 15 cents per dollar of tax revenue to somewhat more than one dollar, the majority apparently being in excess of 50 cents.

Usher estimates the costs of conceiving and administer a Canadian subsidy program as being roughly 10 cents per dollar of subsidy. As for the costs incurred by subsidy recipients (or, more accurately, applicants), these are estimated at 5 cents per dollar of subsidy. Usher also brings in, however, another substantial cost element of a rather interesting kind – namely the tax benefits that the recipient forgoes because of the subsidy. As he points out, subsidized investments are not subject, for tax purposes, to capital cost (depreciation) allowances, investment tax credits, special R&D write-offs, and the like. He goes on to suggest that this has the effect of reducing the subsidy's value to the recipient – a reduction that he estimates as being roughly equivalent to one-third of the subsidy. In other words, according to this notion, every dollar of subsidy paid is worth only about 65 cents to the recipient. Usher then proceeds to express the various administrative and recipient costs as percentages of this lower amount – i.e., in per-dollar-*received* terms, rather than in per-dollar-*paid* terms. Not surprisingly, this increases substantially the total cost of every subsidy dollar received by recipients. It is worthwhile pausing briefly to consider the appropriateness of this approach.

A tax-induced gap between subsidy-dollars paid and subsidy-dollars received arises, if at all, only in specific circumstances where the subsidized investment activity totally displaces other investment activity that the recipient firm would otherwise have undertaken on its own. In other words, Usher apparently assumes in this approach that the subsidy has zero incrementality to the investment behaviour of the firm. But this is obviously not the only conceivable state of affairs. Before going on to other possibilities, however, it might be useful to look a little more closely at this zero-incrementality situation. Consider, first, the deductibility from taxable income of depreciation expense. This provision exists because depreciation – the loss of useful life of an income-earning asset – is a cost like any other cost of earning income. Implicit in the deductibility provision is the requirement that the depreciable asset be acquired by the firm through an outlay of its own resources. An asset financed by means of a subsidy is, by definition, not acquired in that fashion; instead, it is the result of a tax-free gift to the firm from the government – a gift, moreover, that enables the firm to divert an equivalent amount of its own resources to some other income-earning purpose. It would be quite anomalous for the firm to be permitted to deduct from taxable income the depreciation on an asset acquired as the result of a tax-free gift. Such

depreciation is not really a cost to the firm. The "value" to the firm of such a subsidy should therefore be regarded as the present value of the income flow generated by this tax-free gift: unlike analogous income flows generated by a firm's "own" assets, this one is not subject to an opportunity cost. This puts the question of the above gap in a very different, no longer invidious, light, especially if the reasonable assumption is made that the firm equates, at the margin, the returns from all of its assets, however acquired. The very existence of the above gap under these circumstances is thus open to question.

In any event, the zero-incrementality case hardly reflects the government's objective in awarding the subsidy. Though it is in some cases only implicit in its mandate (this being less common nowadays), every subsidy program is intended by the government to add to, rather than replace, the firm's own R&D activity. The objective, indeed, is more ambitious than that: it is to induce the firm to increase its own, self-financed activity beyond what would otherwise have been undertaken – and to a degree that bears a certain relationship to the subsidy. The most frequently sought relationship is one to one. Even if the subsidy fails to elicit any increase in the firm's autonomous R&D spending, if it merely leaves the pre-existing level unaltered, there can be no question of the existence of a gap between dollars of subsidy paid and dollars of subsidy received. Every dollar of the subsidy is incremental to the firm, and the firm forgoes no benefit (tax relief or other) that would otherwise have been enjoyed. This is also true, *a fortiori*, where the subsidy induces the firm to increase its own investment activity to any degree.

As will be seen later, when evidence pertaining to their impact upon recipient firms' own R&D spending is reviewed, federal subsidies tend, on average, to either bring forth increases in that spending or leave it unchanged. All things considered, it would therefore seem reasonable, when estimating the costs of subsidy programs, to regard a dollar of subsidy paid as being equal to a dollar of subsidy received.

On the basis of the foregoing, the total cost per dollar of subsidy paid is estimated to be as follows:

Cost of conceiving and administering the subsidy program	$0.10
Cost to firms of applying for subsidies	0.05
Cost to taxpayers of tax compliance	0.06
Deadweight loss resulting from tax (arbitrarily positioned within the range of various estimates)	0.60
Total	$0.81

The Impact of Subsidies upon Total Investment

When the government imposes a tax – say a personal income tax – in order to raise the money it transfers to selected firms in the form of innovation subsidies, it reduces real personal disposable income and thus its two real components: consumption and personal saving. It also incurs and inflicts highly significant costs in the process, as we have just seen. In order to put one dollar of subsidy into the hands of a firm, it must impose a tax and incur and inflict costs that, together, total $1.81, to use the above estimates.

The effect of the subsidies upon the behaviour of recipient firms is of central importance to the macroeconomic consequences of the tax-subsidy transfers. These consequences will initially be couched in terms of the changes induced in the aggregate levels of investment, consumption, and savings, the question being whether, as the result of the transfers, the equilibrium level of investment (and savings) is higher or lower than it would have been otherwise.

As will be discussed later in detail, it is characteristic of the subsidy programs reviewed that the subsidies were intended, implicitly or explicitly, to induce recipient firms not only to undertake innovation projects that would not otherwise proceed but also to share in their costs. Put another way – and regardless of whether existing cost-sharing arrangements are appropriate – the government's intention was to promote new R&D investment equal to the sum of the subsidies and the additional, subsidy-induced R&D spending by the recipient firms.

If this intention is fully realized and if, for example, the government and the firms share equally in project costs, this new investment will amount to twice the subsidies. It is convenient, in discussing the effect upon aggregate investment, to look first at the subsidy component. Consider, for example, a subsidy of $100, involving costs of $81, and assume that the economy is characterized by a constant marginal propensity to save (s), of .25. Defining the identity

$$I_g + L = s(I_g+L) + (1-s)(I_g+L), \qquad (13)$$

where I_g = subsidy paid (all of which is applied to new R&D);
L = total costs associated with the tax-subsidy transfer; and
s = marginal propensity to save,

implies that the $100 that went into new R&D via the subsidy – which involved taxes and other costs

totalling $181 – has been financed from saving to the extent of $45 (.25 x $181) and from consumption to the extent of $136 (.75 x $181). This means that equilibrium saving and investment have both increased by $55, while consumption has fallen by $136.[9]

As for the effect of the corresponding $100 that the firm added to its own R&D spending when it received the subsidy, that depends upon which alternative assumption about personal saving and consumption is preferred. The underlying notion is that the firm generates this extra $100 from current earnings, by increasing its corporate saving and reducing its dividends. Hence the disposable personal income of the firm's shareholders is reduced by $100. On the other hand, the firm's equity is increased by the same amount – an increase that could be reflected (more or less fully and more or less immediately) in the market value of its shares. This serves to endow its shareholders with an unrealized capital gain. What is uncertain *a priori* is the extent to which this increased corporate saving is reflected in the personal saving (and consumption) behaviour of the shareholders. If it is assumed that shareholders regard the additional saving by their firm as fully equivalent to additional personal saving on their part, it follows that they will reduce their personal saving *pari passu*, thus leaving their consumption unchanged. If, on the other hand, they regard the equivalence between "their" corporate saving and their personal saving as less than complete – which could happen, for example, if share prices did not rise in full accordance with the increased corporate saving – then there would not be a fully offsetting decrease in their personal saving. The difference would be reflected in reduced consumption. On balance, it seems reasonable to suggest that, while the assumption of no reduction in consumption is perhaps too strong, it is likely that whatever reduction did occur would be very small. In other words, the subsidy-induced increase in the recipient firm's own R&D spending would represent but a small increase in total savings and investment in the economy – so small that we shall disregard it for present purposes.

It is clear that the above increase of $55 in total investment depends upon complete effectiveness on the part of program administrators in confining their awards to projects that are fully incremental to both the firm and the industry and in calculating them optimally. Either lesser ability on their part to appropriately support incremental projects (while avoiding non-incremental ones) or more costly programs would produce smaller increases in investment. Indeed, it is not difficult to conjure up any number of combinations of low overall rates of incrementality and high tax-subsidy transfer costs that would produce lower rather than higher levels of aggregate investment in the economy.[10]

There is a further consideration, rather analogous to what Usher calls "the infusion effect," that is worth mentioning. What the subsidy does in effect is extract, by means of taxation, resources from the economy as a whole so as to increase investment in a particular industry. If the supply curves of the investment goods relevant to that industry are all fairly flat (or if, as is more likely, they are not, but the increased investment forms only a negligible proportion of total investment activity in the industry), then the cost of investment goods to the industry will remain unchanged (as will the level of total investment in the latter case). If, on the other hand, the relevant supply curves have positive slopes or the shifts to the right in the industry's demand curves for investment goods are not negligible, this may well have the effect of rendering unprofitable some investment activity that the industry would otherwise have undertaken. Such now-unprofitable investment activity will therefore not take place, and there will occur a corresponding reduction in saving and an increase in consumption. Although it is unlikely that the average subsidy of the type under consideration will be large enough to produce, by itself, perceptible, offsetting reductions in total investment, the same cannot be said of all the aggregations of subsidies paid to firms in specific industries under the individual and collective programs reviewed herein. For, as will be seen later, subsidies paid under these programs tend to cluster in certain industries. Whether these clusters are sufficient to revise the foregoing impression of a negligible infusion effect becomes, therefore, a purely empirical question that only future research can resolve.

The Impact of Subsidies upon Total Welfare

The foregoing discussion of the impact of R&D subsidies upon total investment, though useful in itself, does no more than set the stage for discussing the decisive issue – namely, the impact of the subsidies upon society's welfare. To do that, we must focus on the inappropriable-social-benefit dimension that played such a critical role in the earlier discussion of the microeconomic factors pertaining to project-specific subsidies. It has just been shown that, apart from using up resources in the process, what the subsidization of an incremental project accomplishes at the level of the economy is the conversion of a certain amount of investment – from the unknown (and unknowable) form that it would otherwise have taken into a specific, known form –

and the conversion of a certain amount of consumption spending that would also have occurred into a lesser amount of the same specific investment spending. It also induces a change in the way that the firm allocates its own resources. Now we know that if the two conditions specified earlier as being necessary (though not sufficient) for the (optimal) validity of the subsidy are satisfied, the inappropriable benefits associated with the subsidized project will not only equal but will generally exceed, perhaps by a great deal, the amount of the subsidy. This excess, however, cannot be considered the whole of society's gain from the subsidy. It must be reduced by the benefits forgone as the result of the investment spending precluded by the tax-subsidy transfer. The problem is that these benefits cannot be measured – deriving, as they do, from economic events that were aborted by government action. Does this mean that their value is entirely indeterminate, and does this, in turn, serve to vitiate the very basis of the rationale for the subsidization of innovation projects? What follows are some tentative thoughts on this question, which has apparently not yet received attention in the literature.

Consider further the above illustration, in which a subsidy of $100 involved costs of $81. Given the various assumptions made, including that of a marginal propensity to save of .25, this transfer occurred at the expense of forgone savings of $45 and forgone consumption of $136. We know that the inappropriable benefits generated by the subsidized innovative investment activity have a lower limit of $100. We may assume, however, for present purposes that the "representative" case will involve a significant excess of inappropriable benefits over the subsidy. This, in actual, individual cases, will not be a matter of speculation. An important part of the overall argument developed in this study (to be considered shortly) is that the measurement problems with respect to inappropriable benefits have been, or can be shown to be, manageable in both *ex ante* and *ex post* terms. The same (and other) evidence that supports this view also suggests strongly that the inappropriable benefits obtainable via R&D and related activity can be very high, often representing a multiple of the cost of the activity. Since the subsidy, by definition, can only amount to a fraction of this cost, the excess of inappropriable benefits over the subsidy is capable of being very high indeed. Hence, on average, a value of inappropriable benefits well over $100 may realistically be assumed to obtain.

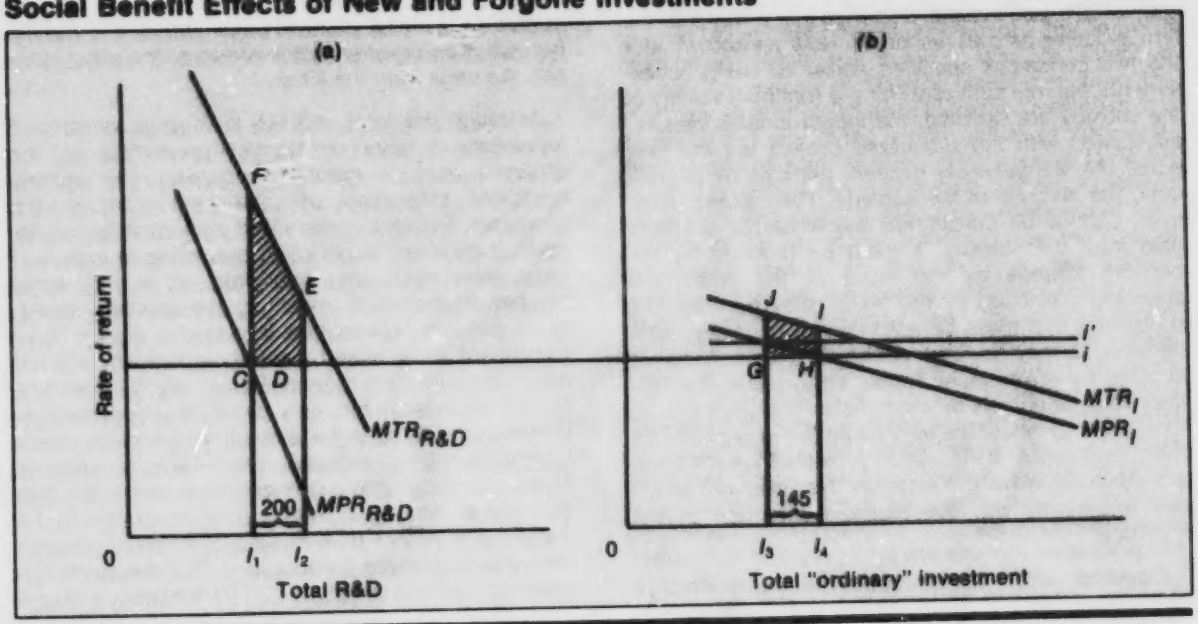
What can we say (speculative though it must be, in the absence of empirical evidence) about the inappropriable benefits attributable to the $45 in savings and investment forgone because of the tax-subsidy transfer and to the $100 in investment elsewhere in the economy forgone because of the firm's contribution to the subsidized project? Two related approaches come to mind: one imposes a certain burden upon program administrators; the other does not. We begin with the latter.

Although the total of $145 in forgone investment represents a very substantial proportion of the project's cost, it naturally represents an entirely negligible proportion of total investment in the economy. Being a generalized reduction in investment, it can be thought of as consisting of individual reductions, each also negligible, in a very large number of individual (more or less divisible) investment activities. Given that it is in the nature of all investment undertaken by entrepreneurs who are not price-discriminating monopolists – which is to say, almost all investment – to generate inappropriable benefits, the following assumptions could be made regarding total "ordinary" (non-R&D) investment. These rest upon the just-mentioned possibility that the returns earned by R&D tend in reality to be substantially higher than those earned by "ordinary" investment. It could be assumed that the marginal-total (social)-rate-of-return (MTR) function and the associated marginal-private-rate-of-return (MPR) function of total "ordinary" investment both have lower slopes than their total R&D counterparts. It could also be assumed that the vertical distance between these two functions is, for total investment, much smaller than it is for total R&D. Since this vertical distance represents the marginal inappropriable rate of return, all this amounts to the assumption that the marginal inappropriable benefits of total "ordinary" investment are not only lower than those of total R&D but also relatively small in their own right. It could finally be assumed that, at the margin, the inappropriable benefits of total investment are so small as to be negligible. This implies that the marginal inappropriable benefits forgone are negligible in total; so too, therefore, are the marginal inappropriable benefits forgone in all individual investment activities. This, from the standpoint of program administrators, has the comforting implication that they may safely disregard the inappropriable benefits lost as the result of investment forgone because of both the tax-subsidy transfer and the subsidized firm's reallocation of resources.

The argument in the above paragraph is illustrated in Figure 1-5. Remember that, given full incrementality to the firm and industry, the tax-subsidy transfer causes a new R&D project, totalling $200, to be undertaken at the expense of forgone generalized investment totalling $145. Recognizing that vastly different scales are reflected in the two portions of the horizontal axis, the investment in the new project

Figure 1-5

Social Benefit Effects of New and Forgone Investments



is measured in part (a) by I_1I_2; and it is subject to $MTR_{R\&D}$ and $MPR_{R\&D}$, the marginal total (social) rate of return on R&D and the marginal private rate of return on R&D, respectively. Since the marginal inappropriable rate of return on R&D is the vertical distance between these lines, the total inappropriable benefits generated by the project are equal to area *CDEF*.

Because the subsidy has caused the supply curve of investment funds to shift to the left, the market rate of interest rises from i to i'. As is indicated in part (b) of the diagram, this implies that total "ordinary" investment decreases by I_3I_4. This decrease is the sum of the very much smaller decreases in a very large number of individual investment activities. Given that total "ordinary" investment is subject, respectively, to marginal-total-rate-of-return and marginal-private-rate-of-return functions of MTR_I and MPR_I, the total inappropriable benefits forgone because of this decrease are represented by area *GHIJ*. It is assumed above that this area, which pertains to the total inappropriable benefits lost because of the sum of the decreases in a very large number of individual investment activities, is itself of negligible size. Thus the marginal inappropriable benefits lost in each individual activity are negligible, *a fortiori*.

The fact is, however, that virtually nothing is known at this juncture about the inappropriable benefits generated by what might be termed the "representative" non-R&D investment activity. Thus the possibility cannot be excluded that these marginal benefits are, in general, not negligible; and, if they are not, their sum over a large number of activities is certainly not negligible. If this is really the case, and given its very considerable importance to the efficacy of subsidy programs, it would be prudent for the administrators of the various subsidy programs to collectively devote some resources to investigating the question. This investigation would fit naturally into the various other cooperative activities that would be in their common interests, which are discussed below.

Even though it may not mark such a radical departure from existing products or processes as the innovations tested in Appendix B, a large proportion of "ordinary" capital formation represents some degree of innovation, in the sense that it improves, rather than merely replicates, the existing capital assets that are replaced or augmented. The additional machines installed in a factory tend, for example, to be the latest models; new or extended buildings tend to be more efficient than existing ones; and so on. Thus it is not impossible to examine many

(perhaps most) of the "ordinary" investment projects from the Griliches-Mansfield perspective that will be described shortly and estimate their total and private rates of return. Granted these are average rates rather than the marginal rates that are required, strictly speaking; but this limitation need not prevent them from being useful. If, for example, analysis of a sample of "ordinary" unsubsidized projects revealed that the average inappropriable rate of return is usually low, this result would be consistent with the existence of extremely low (i.e., negligible) inappropriable rates of return at the margin.

It is probably unrealistic to expect that program administrators, however cooperative their efforts, are likely to be in a position to develop a scientifically sound sample of "ordinary" investment projects, but even a small *ad hoc* sample would have value. What is wanted, after all, is some empirical evidence pertaining to the inappropriable returns generated by investment activity. Even a nonscientific, but honest, sample would be better than none; and, once developed, it could be updated at intervals, thereby becoming more reliable as time passed. If it failed to lay to rest the spectre of significant forgone inappropriable benefits, it might conceivably provide a basis for some sort of arbitrary premium that all subsidized projects would be required to bear. It need hardly be said that arbitrariness in decision making by government officials is, in general, undesirable; but, as is suggested elsewhere in this chapter, it is appropriate that recipients of society's largesse be held to standards that err on the side of conservatism.

Assuming, for present purposes, that the inappropriable benefits of the investment forgone are negligible, the only other amount that needs to be set against the excess of the inappropriable benefits of the subsidized project over its subsidy is the total cost of the tax-subsidy transfer – namely, $81 – in terms of the above example. Relation (10) must now be rewritten as:

$$g' - G' = S < B' - G' - C, \qquad (14)$$

where C denotes the total cost of the tax-subsidy transfer.

Given that the subsidized project is also incremental to the industry, this relation specifies both the necessary and the sufficient conditions of the optimal subsidy.

There is a further conceptual point that should be made explicit. The resources involved – certainly the costs – in tax-subsidy transfers are derived from the economy as a whole. Subsidy program administrators should therefore seek to support projects whose benefits will be distributed more, rather than less, widely throughout the economy. It could be argued that projects whose resulting products were not widely distributed could serve society's interests as long as the Hicks-Kaldor type of conditions were met – i.e., as long as the relatively few gainers could, if necessary, more than compensate the many taxpayers. But program administrators could not reasonably be expected to make the nice calculations that such judgments would entail. It would be more sensible for them to be required to incorporate into their perspectives a bias in favour of projects whose benefits were, if not nationally, at least widely distributed.

More Practicalities: The Measurement of Inappropriable Social Benefits

In view of the critical importance of inappropriable benefits to the issue of the efficacy of innovation subsidy programs and given their inherently intangible nature, the question naturally arises as to whether the inappropriable benefits attached to a specific project are capable of being measured with reasonable accuracy. In order for this measurement to be useful to a program's sucsessful functioning, it must be possible to take it twice: first, prospectively, when the project is being considered for subsidization; and later, retrospectively, after the project has been completed and its fruits are discernible. This aspect of the problem, however, is more apparent than real. If not axiomatic, it is at least generally true in economics that what can be estimated *ex post* can also be estimated *ex ante*.

Before taking up various practical questions, the conceptual character of inappropriable benefits needs some clarification. As was frequently made clear above, this notion refers to benefits derived from an innovation that the innovator cannot, because of market factors, appropriate unto himself. For the purpose of this study, inappropriable benefits will be deemed to be real only insofar as they exist in the "eye" of the consumer of the innovative product – an existence that manifests itself in his willingness to pay for them. Looked at in this fashion, the inappropriable benefits generated by a given commodity can be located on and to the left of the market demand curve for that commodity. More specifically, they can be conceived of in terms of consumers' surplus.

Consumers' Surplus

The concept of consumers' surplus – together with its encompassing conceptual companion, economic surplus – has for more than a century occupied a prominent, if controversial, place in the edifice of economic theory. Hicks (1939) and Mundell (1962), for example, declared it to be one of the major pillars

of modern economics. Other illustrious writers, such as Little (1960) and Samuelson (1967), took opposing positions. These various views no doubt reflect the different perspectives from which the concept can be viewed.

Our perspective is that of Dupuit (1844), who was perhaps the first writer to deal explicitly with the notion of consumers' surplus. According to him [p. 39], consumers' surplus consists of "the difference between the sacrifice which the purchaser would be willing to make in order to get... [a given commodity] . . . and the purchase price he has to pay in exchange." He suggests that it is represented by the triangle-like area bounded by the demand curve, the price line, and the connecting portion of the vertical axis.

A series of subsequent writers, including Marshall (1930), Hicks, and Patinkin (1963), addressed many of the rather numerous theoretical requirements, as well as the broader implications of Dupuit's formulation. These have included the requisite assumptions as to the marginal utility of money, problems of aggregation over commodities and individuals, and alternative ways of conceptually measuring the welfare effects of a price change. There is no need to review here the extensive literature that has emerged, bearing on these issues. (Interested readers may consult Currie, Murphy, and Schmitz (1971) for that purpose.) It is sufficient to point out that the use of the concept of consumers' surplus in this study and in others involving innovations, along the lines developed by Dupuit, reflects the needs of the specific exercises. Other formulations might well be more suitable for other purposes.

We suggest, in other words, that the area of Dupuit's triangle may be taken, for purposes such as ours, as the economic value of the unpaid-for benefits that the consumers of a given commodity derive from being able to buy it at its equilibrium price. This, of course, implies that the change in this area represents the welfare gain (loss) that these consumers derive from a given decrease (increase) in the equilibrium price of the commodity. Successful innovations usually result in lower prices for one or more commodities and in corresponding welfare gains for consumers, which may be conceived of in terms of this incremental area. Since a given subsidy consists of a specific sum of money, the question inevitably arises as to how, for practical purposes, this additional consumers' surplus can be measured so as to be comparable with that sum plus its attendant costs. This is a vital issue as far as this study is concerned. Unless it can be shown that the estimation of incremental consumers' surplus with reasonable accuracy is a practical proposition, it is difficult to make a case for the continued existence of project-specific subsidy programs. Fortunately, on at least two occasions, others tackled much the same question, although for reasons that differed from ours. Let us therefore consider these efforts to see whether they constitute useful precedents, from the standpoint of subsidy program administrators.

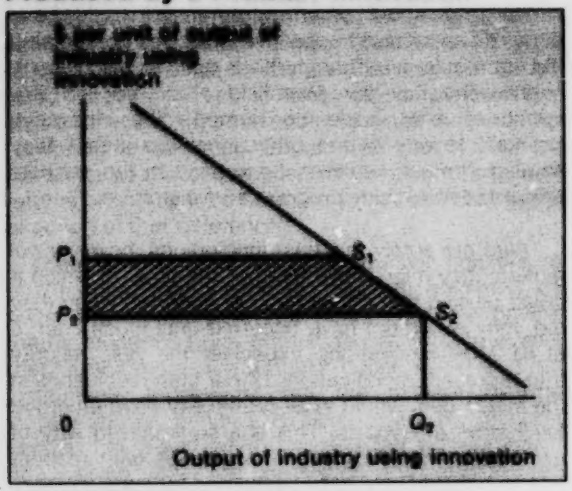
We must, however, go beyond that. Although it is true that the measurement problems that most innovations present involve incremental consumers' surplus, there are cases in which it is necessary to estimate the entire area under the demand curve – the entire consumers' surplus generated by a certain level of output. Such cases are rare, but they do occur, as in the case where the innovation consists of a new commodity that satisfies a need that has never before been satisfied. Examples are not easy to come by; but perhaps the case of a new medicine, one that is efficacious for an ailment previously beyond therapeutic reach, may serve. As far as is known at present, there are no published studies analogous to those pertaining to incremental consumers' surplus upon which to draw. The literature is not entirely barren, however. [Passing, but relevant, references are made to the problem in Treasury Board Secretariat (1976), p. 16; and in Prest and Turvey (1965), pp. 691-92.] We shall therefore discuss ways of tackling the problem on a more or less *tabula rasa* basis. We begin with the measurement problem presented by incremental consumers' surplus.

Measuring Incremental Consumers' Surplus: Two Relevant Exercises

In the above-mentioned, seminal study, Griliches estimated the R&D costs and inappropriable returns associated with the innovation of hybrid corn. More recently, Mansfield *et al.* reported 17 case studies in which both the total (social) and the private rates of return to R&D invested in specific innovations were estimated. The analytical approaches adopted by these authors are similar but not identical. Since the 17 successful innovations studied by Mansfield *et al.*, being industrial innovations, are far more likely to be characteristic of the types of projects subsidized by the programs under consideration in this study, their exercise will receive our closest attention. Another relevant feature of this set of innovations is that it comprises both product and process innovations – 13 of the former and 4 of the latter. Still another relevant feature is the fact that 14 of these innovations involve intermediate goods consumed by firms, the remaining 3 are consumed by households. Thirteen of the innovations emerged from separate industries; four emerged from a single industry (chemicals). The situation with respect to a product innovation is depicted in Figure 1-6.

Figure 1-6

Incremental Consumers' Surplus Produced by a Product Innovation



SOURCE Mansfield *et al.* (1977).

The incremental consumers' surplus generated in each period by a given innovation is represented by the shaded area $P_2S_2S_1P_1$. A linear approximation of this area is given by

$$(P_1 - P_2)Q_2(1 - \tfrac{1}{2}Kn),$$

where $K = (P_1 - P_2)/P_2$ and n is the absolute value of the elasticity of demand for the (consumer good) product *produced by the industry using the innovation.*[11]

To estimate $P_1 - P_2$, executives of the innovative firm and a sample of executives of firms using the innovation were interviewed. Other evidence, such as internal studies, was also examined when available. P_2 was generally obtainable from published records, as was Q_2. The n was naturally more difficult to estimate, but rough estimates were obtained from published studies and from the firms. *Happily, the roughness of these estimates of* n *proved to be a minor worry.* Since K was usually very small, the overall result was not sensitive to errors in n. *Indeed, these authors go so far as to suggest that the above expression can be closely approximated in most cases by*

$$(P_1 - P_2)Q_2,$$

which represents the total savings to consumers in each period if they purchase Q_2 units of the product of the industry using the innovation. This, needless to say, is, for our purposes, a most useful consideration. It means, in effect, that in order to estimate the per-period inappropriable benefits that the innovation will generate, program administrators will usually need to ask themselves only two questions: What is the amount of price reduction that consumers will receive as the result of the innovation; and how many units of the consumer good in question will be sold during the period? It should also be noted that the answers to these two questions emerge automatically from the estimation of the innovation's private returns, thereby simplifying life appreciably. Granted, innovations that are rather "revolutionary" will require the estimation of n (since Kn will no longer be very small), but such innovations will be the exception rather than the rule.

There are, of course, a number of caveats that must be reckoned with when adopting this approach. One of them is the implicit assumption that the innovation-using industry's supply curve is horizontal in the relevant range. In many cases this assumption is probably realistic enough but not in every case. The question is how much potential distortion is risked in making it. Griliches computed two estimates of incremental consumers' surplus – one based on a horizontal supply curve and the other, on a vertical one. He found that there was only 7 per cent difference between the two estimates. Since this difference could be regarded as the maximum potential distortion in the situation, the true distortion was probably less; in any case, the maximum was not great. Thus it seems reasonable to suggest that an assumed horizontal supply curve will generally serve. This implies that the cost saving that results from the innovation is fully passed on to consumers of the product of the industry using the innovation. Mansfield *et al.* considered this assumption reasonable, given the market structures of the industries in question. It is likely to be similarly reasonable in a majority of other cases.

With only minor modifications, most of them involving changes in the labels of the axes, Mansfield *et al.* used the above model for all of the 17 innovations upon which they report. In other words, their approach accommodates process innovations, innovations that result in products consumed as inputs by other firms, and innovations that directly satisfy final demand – i.e., consumer goods. The last type of innovation can take two forms: cheaper, or improved, versions of existing consumer goods or altogether new ones. Clearly, then, the model, if its applicability is to be general, needs to be understood

in ways that will allow it to accommodate all of these possibilities.

With respect to the last type of innovation, the case of a cheaper version of an existing consumer good is straightforward, but that of an improved version is not. In order for the model to be applicable, quality changes must be translated into value (i.e., price-reduction) equivalents. This is never an easy task, but it is one that is commonly performed, as those who calculate price indexes for statistical agencies can testify. The relatively rare case of the utterly new and unprecedented consumer good presents a different problem: it will be discussed in the next section. A far more likely situation is the one that involves a commodity that satisfies an existing (and served) consumer want but in a new way. Such a commodity, however much it may differ from its functional predecessors, is to be regarded for present purposes as an improved version of existing goods and, as such, is capable of being handled along the foregoing lines.

An awkward, practical problem could arise if the number of consumer-good industries using the innovation is large. The estimating procedure would, in effect, need to be repeated for each such industry that consumed the innovation on a sufficiently large scale. Judgment is obviously called for here in deciding the minimum volume of sales of the innovative commodity to the various industries, so as to isolate those industries really requiring analysis. On the whole, it does not seem likely that there will be many innovations that compel analysis of more than a few, and in most cases very few, user-industries. If, as a practical matter, the industry that is the major consumer of the innovation were examined, this would usually suffice. In other cases, two (or at most three) industries will require consideration.

There are two additional, and important, caveats to be discussed. The estimates by Griliches and by Mansfield *et al.* are all *ex post*, unlike the *ex ante* estimates that program administrators must make. With one exception, they measure both the total and private benefits of the various innovations generated, from the time of each innovation's emergence up to a certain, common, terminal date. The single exception (reported by Mansfield *et al.*) pertains to an innovation of which it was known that some other entrepreneur was engaged in an analogous project prior to its appearance – a project that ultimately proved to be successful. In other words, this particular innovator's project would, in our context, probably not have qualified as being incremental to the industry. The authors dealt with this consideration by crediting the innovation with only those social benefits estimated to have been generated during the interval between the time of its appearance and that of the successful completion of the analogous project. They recognized, in other words, that this innovator's contribution consisted of making the innovation available earlier than some other entrepreneur would have done. Because their respective exercises presumably did not require it (although this is open to discussion), neither Griliches nor Mansfield *et al.* applied this notion of what could be termed "the innovative interval" to any of the other innovations that they studied. It must, however, be applied to the projects presented to subsidy program administrators.

There are surely few past innovations, however *sui generis* they might have been at the time, of which it could be said that if they had not occurred when they did, they would not have occurred until much later, if at all. Most innovations, especially the vast majority that represent modifications rather than revolutions in the *status quo*, would in all probability have emerged fairly soon afterwards. This is a summarized way of expressing the following contingencies with respect to any project likely to be presented for subsidization:

a) The probable result of this project will be to expedite the advent of the innovation in question by a certain period of time. If this project does not go ahead, some other entrepreneur will probably undertake a very similar one in the not-too-distant future. Now that will not happen.

b) It is not inconceivable that the obviated future project could have been undertaken more efficiently than the present one. Hence, it would not have needed any subsidy or else it would have needed a smaller one than the present project requires.

Thus the effect of the subsidy is that it enables one entrepreneur to preclude today what another, possibly more efficient, entrepreneur would have accomplished – if not tomorrow, then the day after. This way of looking at the innovative process becomes all the more plausible when we consider that most innovations – certainly most innovations likely to be subsidized under the programs being reviewed – do not emerge spontaneously out of whole cloth, from "autonomous" inspirations having no connection with the prevailing technical and economic environment. Instead, they emerge precisely because someone, standing on the shoulders, so to speak, of what has gone before, surveys that environment and perceives a certain need and a certain prospect. What is perceptible to one observer can also be, and usually will be (though not necessarily immediately), perceived by others. But the subsidy, by allowing one – apparently the first – perception to become a reality tends to render later ones redundant. Their fruits, therefore, never see the light of day.

The question that now arises is: Over what time horizon should the subsidized project's inappropriable benefits be projected and discounted? Strictly speaking, these benefits will continue to emerge forever; but that is irrelevant to the issue, which is confined to the length of the benefit flow that is uniquely attributable to the behaviour of the subsidized innovator – i.e., to those inappropriable benefits that would not have emerged when they did had he not acted as he did. Should their time horizon be the same as the one applied to the project's private returns or should it be different; and, if so, what is the direction of that difference?

There is no inherent reason for the two horizons to be of equal distance, since they are governed by quite different factors. The horizon for the private returns depends upon market forces – upon events that, furthermore, *will* actually occur within a given institutional framework. But the horizon for the inappropriable benefits is determined by different events that *would have occurred* but will *not* occur now, given that the innovation in question has emerged. There is also no inherent reason for the distance of one of those horizons to be either shorter or longer than the other. Consequently – and regardless of the view of the relative lengths of the two intervals – arbitrariness on the part of the subsidy program administrator is unavoidable. Obviated events are, after all, unobservable by definition. The recent technological history of the industry, the degree to which the project promises to be *sui generis*, and similar factors may shed some light; but their combined capacity to illuminate the landscape must inevitably be limited.

It is the view of the present writer that it would be best if program administrators were to manifest this arbitrariness by consciously erring on the side of conservatism – by leaning, in other words, in the direction of underestimating, rather than overestimating, the length of the innovative interval. As is suggested in various places herein, the custodians of society's largesse should always err on the side of conservatism, if err they must. This tends to imply that horizons of the order of 2 to 3 years will usually be called for. Horizons that are farther away than five years are hard to imagine, however distant the horizons for the corresponding private benefits. It should be laid down in the program's operating rules that in addition to their other burdens the burden of persuasion as to a project's innovative interval rests squarely upon the shoulders of the applicant firm.

Before leaving the subject of the innovative interval, a further, parenthetical word is in order. Since innovations beget later innovations that in turn beget still others, interminably, it follows that the subsidized innovation should, in principle, be credited with the inappropriable benefits generated by all of its descendant innovations during the time spans by which their respective advents were speeded up. The practical difficulties involved in making any such calculations are, of course, quite insuperable. But even if they were not, the numbers of years in the future before these benefits would materialize would generally be such as to render negligible their present values. This entire dimension can therefore be safely disregarded by program administrators.

A final caveat also needs to be raised here, with reference to the estimation of the inappropriable benefits to Canadians that are generated by the exports of a subsidized innovation's ultimate product. As is explained in some detail in a later chapter, estimating the inappropriable benefits from a given volume of exports of a given commodity is a very tenuous business indeed. It is therefore best that, here too, program administrators put on a conservative hair shirt. More precisely, they should assume that exports of the product in question will produce no inappropriable benefits for Canadians. They should focus, in other words, only on the domestic sales of the product and upon their inappropriable benefits. Thus any innovation aimed at a product whose expected domestic sales are such as to generate enough inappropriable benefits to justify a given subsidy will deserve that subsidy all the more if it also results in exports.

Measuring Total Consumers' Surplus

We now consider the measuring of the area of the entire Dupuit triangle rather than just the increase in that area. This becomes necessary when, as was indicated above, the project promises to result ultimately in a quite new consumer good.

The problem would be straightforward if we knew the demand curve for the commodity. Total consumers' surplus would be equal to the area bounded by that curve, the price line, and the vertical axis; that is, it would be equal (as a linear approximation) to one-half the product of total output and the distance along the vertical axis between the price and the intersection of that axis and the demand curve. But, of course, the demand curve is unknown to us and will remain so, for all practical purposes; hence it is necessary to resort to the second-best.

The critical unknown is at the intersection of the demand curve and the vertical axis. The price at that point approximates the maximum price that some consumer is willing to pay for a very small amount of the commodity rather than do without it. In reality, there is usually only one type of entrepreneur that has reason to calculate that price – namely, the price-discriminating monopolist. Fortunately (for our

purposes) enough examples are at hand – public utilities, and so on – to justify the belief that what he can estimate routinely, program administrators can replicate on the relatively rare occasions when they must. The price-discriminating monopolist discriminates because he is, of course, a monopolist but, more pertinently, because he is dealing with different categories of consumers who cannot readily change their category. Consider, for example, the industrial user of hydro-electricity vis-à-vis the residential user. Even if the boundaries are not always so easily delineated, it will generally be possible to segregate, more or less analogously, most consumers of most commodities. It then remains only to decide which category of consumer is most characterized by the highest combination of desire and ability to pay – i.e., whose effective demand is greatest. Subtract the equilibrium price from the maximum price that these consumers will pay, if they must; multiply that difference by total output; and then halve the product. The resulting amount may be regarded as a rough, though probably adequate, linear approximation of the total consumers' surplus generated per period by that output of the commodity. The several remaining aspects of the measurement problem are similar to those relating to incremental consumers' surplus and were already discussed in the preceding section.

The Practicalities in Perspective

It was argued in an earlier section that a given subsidy must satisfy conditions that extend well beyond the specific subsidized project in order to qualify as being potentially beneficial to the economy as a whole. Not only must the subsidy be confined to projects characterized by prospective private deficits (and serve, optimally, only to offset those deficits) and not only must the project have the prospective capacity to generate inappropriable benefits greater than the subsidy, but this excess itself must meet other requirements as well. These requirements derive from two facts. One is the fact that the various governmental activities involved in effecting tax-subsidy transfers are costly. The other is the fact that the resources transferred from the taxpayers to the subsidized firm and the resources reallocated concomitantly by that firm could conceivably also have social opportunity costs attached to them. In order to make society better off, the inappropriable benefits generated by the subsidized project must exceed not only the subsidy but also the sum of the subsidy and those various costs.

All this places quite an onerous burden upon the shoulders of the officials charged with the administration of subsidy programs. While the projection of a proposed project's costs and private benefits is never an easy exercise, it is, however, an exercise that is performed routinely by firms and by various participants in capital markets – banks, underwriters, financial market analysts, and the like. What *they* can do, program administrators can do, especially when able to command the cooperation of the applicant firms.

The estimation of a proposed project's future inappropriable benefits is, in principle, a more challenging task; and it should be noted that, whereas the projection of private benefits nowadays is an everyday matter, the projection of these benefits has been done but rarely. It is this fact, far more than the inherent, technical difficulties, that makes this exercise seem the more awkward one. But, as was shown in the discussion of the Griliches-Mansfield precedents, a fairly workable approximation of the per-period inappropriable benefits attributable to a given innovation can be developed on the basis of estimation methods that do not impose burdens heavier than those imposed by the routine exercise. Quite the contrary: the informational requirements of what might be termed "the Mansfield approximation" would be fully met as a by-product of that exercise. There must have been a time when the projection of the private benefits that could rationally be expected from a project was much less commonplace, so it would have appeared to be a far more daunting task than it later became or than it is today. A similar learning-by-doing process is likely to take place in regard to the projection of inappropriable benefits, even though the scale of this activity will never approach that of the projection of private benefits.

We now know, however, that no matter how competently they are made, these projections cannot suffice as the basis of a sound judgment by program administrators as to whether a given project merits subsidization. Additional factors must also be reckoned with, particularly the costs incurred as the result of both the taxes imposed to finance the subsidy and the administration of the subsidy program. Although these factors – consisting of direct costs, deadweight losses, and the like – must be reckoned with each and every time a project is considered for subsidization, they need not be computed *de novo*, as must the project's peculiar costs and benefits, both private and social. Modular estimates are, or could be made, available that would be capable of serving all projects presented for subsidization under a given program during a given, fairly lengthy period of time.

As was suggested above, program costs – expressed in terms of "per dollar of subsidy paid" – can be conceived as comprising four components: the costs of operating the program; the costs to applicants for subsidies; the costs to taxpayers of tax compliance; and the deadweight loss resulting from the tax. Of these, only the first is really program-

specific. It is a function of the size of the program, in terms of the number of applications processed and of the average subsidies that are involved in these applications. In the context of a given program, this item is unlikely to change greatly from one year to the next. An *ex post* estimate of a given year's costs is likely to be an adequate *ex ante* estimator for several years to come. It would not be difficult to verify its adequacy at the end of each year and make whatever adjustments are necessary.

Similarly, the other three cost components will probably not vary greatly over time. Once made, estimates would therefore not only serve all programs but would also last for a fair number of years. Although they could not be as readily verified retrospectively and in the same way annually as the first component, occasional surveys could be done to ensure that the estimates used are not unrealistic.

The Retrospective Evaluation of Subsidy Programs

Like the administration of any other form of government intervention in the economy, that of a subsidy program requires a capability for retrospective evaluation. That alone permits ongoing judgments to be made as to how fully the program's objectives are being achieved and provides the basis for adjustments in its *modus operandi*. The evaluation should attempt to answer two separate questions, the second question arising only if the first can be answered affirmatively. Both questions, however, must be answered affirmatively if a given subsidy program is to be considered successful. How incremental to the firms involved were the subsidized projects? And have subsidized projects tended to turn out approximately the way that was expected when the subsidies were awarded?

The development of answers to these questions, however, requires approaches that differ in various ways from those which are appropriate for other types of economic policies. The effectiveness of certain policies, such as macroeconomic policies aimed at, say, reducing unemployment or inflation, could be discerned to some degree by observing these highly observable variables, which are also measured independently of the administration of the policies directed at them. This is much less true of government programs of the type discussed here. Their objective is to generate more socially desirable, innovative investment activity than would otherwise occur. This requires that they be operated in such a way as to yield affirmative answers to the two questions just posed. But whether they be affirmative or negative, the answers to these questions are not made manifest by the workings of the economy, as measured by independent statistical agencies. Nor, in all probability, could they be. They can only be inferred by means of specially undertaken procedures, some of which are now considered. We begin with an estimation of the degrees to which subsidized projects have in fact been incremental to the innovative firms.

Incrementality to the Firm, Retrospectively

When a subsidized project was not at all incremental to the firm – in other words, when the firm would have proceeded with the project without the subsidy – the subsidy merely replaced an equal amount of the firms's own R&D spending. Its total R&D spending remained unchanged. On the other hand, when a subsidized project was fully incremental to the firm, the firm's total R&D spending increased by the amount of the project's cost – i.e., by the sum of the subsidy and the firm's share of the project's cost. Thus either the firm's total R&D spending or its own R&D spending can be examined to assess the incrementality to it of the subsidized project. To put the issue in terms of the latter, the subsidy caused the firm's own R&D spending to rise to the extent of its share of the project's cost, if the project was fully incremental to it. If not at all incremental, the subsidy caused the firm's own R&D spending to fall to the extent of the subsidy. Intermediate degrees of incrementality would, of course, be reflected in changes in the firm's own R&D spending within these limits.[12]

The actual impact of subsidies upon the autonomous R&D spending of recipient firms can be examined meaningfully only in the context of a model that specifies all of the factors that may conceptually be regarded as bearing systematically upon that spending. One version of such a model was developed recently with respect to Canadian industry by Howe and McFetridge (1976) and was further applied by McFetridge (1977). It is discussed in detail in the next chapter, along with other specifications, and it is applied to data pertaining to the Enterprise Development Program. While very useful as a transitional device, this model cannot yet, as will be seen, be considered entirely adequate to the task of indicating the degree of incrementality of subsidies to recipient firms. Whatever its particularities, however, the ultimately most serviceable regression model will have the general form:

$$R_{it} = a_o + \sum_{j=1}^{n-1} a_j V_{jit} + a_n G_{it} + \epsilon_{it},$$

where R_{it} = R&D spending from its own funds by the ith firm during year t;

V_j = each variable, other than subsidies, that bears systematically upon R_{it} (there are $n-1$ such variables);
G_{it} = subsidies received by the i^{th} firm during year t; and
ϵ_{it} = random disturbances.

When the subsidized project is not at all incremental to the firm, $a_n = -1$, since the firm merely reduces its own R&D spending by the amount of the subsidy. When the subsidized project is fully incremental (and if the firm does not abandon or cut back on other projects because of the subsidy), $a_n > 0$; but the extent to which a_n is positive will depend upon the proportion of the project's total cost that is subsidized. If, for example, half the project's cost is subsidized – a ratio that is frequently sought by program administrators (as will be seen) – $a_n = 1$; if the ratio is one-third, $a_n = 2$; and so on. Since the regression model will generate expected levels of own-R&D spending, it is necessary, when contemplating any estimate of $a_n > 0$, to know the annual ratios that subsidies are expected to bear to projects' costs.

It seems practical to proceed along the following lines, after having summed over all of the firms subsidized under a given program during a given year. The *intended* ratio of each awarded subsidy to its project's total cost is, of course, known to program administrators. Hence the intended subsidy/own-R&D spending ratio is also known. If subsidy instalments are paid *pari passu* with firms' project expenditures, then, for any given year, the average subsidy/own-R&D spending ratio is readily ascertainable. If that year's estimated a_n – i.e., $\hat{a}_n$ – closely approximates this ratio, program administators would be justified in concluding that their incrementality objectives are, on average, being achieved. If $\hat{a}_n$ is substantially below this ratio, this would signify that subsidized projects are generally not (or not very) incremental to the firms involved and that a far-reaching reassessment of the program's procedures for the evaluation of applications for subsidies is urgently called for. Such a situation should probably also be taken to imply a negative answer to the more decisive question considered in the next section.

Incrementality to the Economy, Retrospectively

Even if $\hat{a}_n$ is close to the requisite ratio, the foregoing constitutes only part of the annual exercise that must be performed to determine retrospectively whether a given subsidy program is serving Canadian society in a positive way. There must, in other words, also exist reason to believe that the subsidized projects have in fact been generating a net increase in social benefits.

It is useful to put the conceptual issue concisely. If the approach developed above, or its equivalent, were followed effectively with respect to *ex ante* decision making, the only projects that would have received subsidies would have been those which were expected to produce a net increase in Canada's social well-being. In other words, each subsidized project was expected to generate, over its unique innovative interval, more inappropriable benefits than the sum of the subsidy and the cost of the tax-subsidy transfer. How can it be reasonably verified that this has indeed been occurring with sufficient frequency to justify the subsidy program? As far as is known, there is no theoretical or practical experience to draw upon that pertains to this question. That is one reason for some diffidence. Another, and equally important, reason is the fact that it is unrealistic to lay down a retrospective evaluation system that involves the sort of definitive – and very costly – tracking of all subsidized projects that is desirable conceptually. Sampling is a practical necessity, and this means that more than one alternative approach is probably viable. What follows, then, should be regarded as schematic and tentative.

The objective of this part of the exercise is, in effect, to ascertain the overall soundness of the *ex ante* estimating methods pertaining to the inappropriable and private returns to subsidized projects. With respect to private returns, a considerable number of years must usually elapse before they can be considered to be in – the R&D-tooling-up years plus enough production-sales years for the results of the last year to have a negligible present value. Although this means that, except for projects that are early failures, the decisions of a given year must wait quite a long time before their specific validity can be judged and before necessary administrative changes can be made, not too much should be made of it. Provided the system's procedures are fairly stable, once an initial, average innovation-production cycle has run its course, the results of the analysis of properly selected samples of completed projects can shed a good deal of light on the soundness of current decisions.

An annual analysis would seek to answer two questions:

1) What is the actual average private rate of return on subsidized projects?

2) How do the actual inappropriable returns generated by subsidized projects compare with the anticipated inappropriable returns?

Question (1) is important for more than one reason. First, given the costs involved in making the tax-

subsidy transfer, the loss to the economy from a failed subsidized project is greater than the loss from an unsubsidized failure of similar size. Second, it is necessary to know whether the amounts of the subsidies paid were appropriate. (Since an investigation of the impact of subsidies upon the R&D spending of recipient firms is best done on an annual basis, this analysis should also be done annually.) It is in the nature of the subsidized projects that, except for those aborted early, the vast majority of them probably extend over several years. Consequently, any sample of projects completed during a given year must be composed predominantly of projects begun during various previous years. (Provided there is relative stability in the programs' decision-making procedures, this, again, would not constitute a serious problem.) At the end of a given year, there will thus exist a certain set of projects begun during that year that were aborted on grounds of technical failure; another set of earlier projects that were technically completed during the year but that generated no sales and were not expected to generate any in the future; and a third set of still earlier projects that completed the projected cycle. The projects in the first two sets will, of course, be characterized by negative net returns. As for the third set, its projects will generate a distribution of net returns, both positive and negative. Assuming that a sample of the aggregate of these three sets is of adequate size and provided that the *ex ante* judgments were reasonably sound, the average private rate of return on the projects involved should approximate reasonably closely the average rate of return on capital earned in the corresponding industries. If it does, it may be inferred that, on average, firms are earning only their opportunity costs on subsidized projects, which is precisely as it should be.

If a reasonably close approximation does not exist between these two numbers, this should be taken as a signal that *ex ante* procedures are deficient in one way or another. For example, if the sample average rate of return on the projects exceeds the average rate of return earned in the relevant parts of the private sector, this could indicate that these procedures are not stringent enough and that subsidies are too generous. If, on the other hand, the latter exceeds the former, this could indicate excessive stringency. From the standpoint of society, there is little choice between these two situations: they are both inimical to its best interests.

The importance of Question (2) is self-evident. Unless program administrators can estimate, with reasonable accuracy, both the anticipated and the actual inappropriable returns earned by subsidized projects so as to be able to compare them, the very *raison d'être* of subsidy programs becomes questionable. It has been shown above that this, fortunately, is not excessively difficult. Unlike the private rate of return on subsidized projects, actual inappropriable benefits are no more subject to a desired upper limit than are anticipated ones. From the standpoint of program administrators, the higher these benefits are, the better. The overriding conceptual question, in the context of retrospective evaluation, therefore, is whether or not the set of nonfailed completed projects included in the sample has actually generated enough inappropriable benefits to more than offset the total of the subsidies paid to all the projects in the aggregate sample plus the total costs of the tax-subsidy transfers involved. If it has accomplished this, the subsidy program may, in principle, be deemed efficacious; otherwise, it may not.

It is far from easy to make this theoretical requirement operational, since it does not seem realistic to require that program administrators measure the *ex post* inappropriable benefits generated by all the nonfailed completed projects in the sample. One approach that comes to mind involves making these measurements for a subsample of such projects and then applying the resulting average *rate* of inappropriable return to the other nonfailed projects in the sample, thereby obtaining an estimate of the total inappropriable benefits generated by the sample.[13] More specifically, this would entail the discounting, to the respective years of origin, over the same innovative intervals used in the *ex ante* estimates, of the flows of actual, per-period, inappropriable benefits generated by each of the projects in the subsample and then expressing that figure as a percentage of that project's R&D costs. A weighted average of these percentages would serve as the average rate of inappropriable return to be applied to the other nonfailed projects in the sample. Thus an estimate of the present value of the total inappropriable benefits generated by all the projects in the sample would emerge. This amount could then be set against the sum of the subsidies and the costs of the tax-subsidy transfers. Besides providing a basis for the indispensable judgment as to whether the program is efficacious, this retrospective exercise also provides something of a test of the accuracy of the *ex ante* estimates of the future inappropriable benefits of prospective projects. And, as in the case of private returns, the divergences of outcomes from anticipations are bound to provide program administrators with useful insights into those aspects of their procedures that are in need of improvement.

Interprogram Cooperation

It will become apparent in the following chapters that the great majority of the conceptual and informational problems that face program administrators, in both their *ex ante* and *ex post* decision-making activities, are common to all but one of the federal subsidy programs discussed in this study (and also, probably, to their various provincial counterparts). It is also evident that a good many of the parameters that they require in their work are capable, once they have been estimated, of serving them all. These considerations provide strong justification for the development of formal and practical arrangements for ongoing, close cooperation between the administrations of the various cognate programs, at least at the federal level.

To illustrate, consider the estimation of a proposed project's inappropriable benefits (in addition to its private returns). Given the relatively high levels of concentration that characterize many Canadian industrial sectors, the kinds of information on prices, output, and so on, called for by the Griliches-Mansfield methodology, once gathered, are bound to relate to most, if not all, applications for subsidies presented under the various programs. Quite often, indeed, the same firms will be involved. Most of the cost elements identified earlier as being involved in the tax-subsidy transfer collectively present another important, common concern to program administrators. So does the problem of analysing the determinants of subsidized firms' own R&D spending so as to estimate the extent to which subsidies have been incremental to the firm. And so, of course, do the exigencies of the retrospective evaluation of the outcomes of subsidized projects. It is fair to say that the areas of common interest that can be served by similar methodological devices and information greatly outnumber the areas in which the programs are distinctive.

2 The Enterprise Development Program

The preceding chapter was concerned with various implications of the rather paradoxical fact that the competitive market, which is in principle capable of yielding a number of socially desirable allocative results, is inherently incapable of generating the optimal level of innovative activity. It was suggested that this incapacity constituted a *prima facie* justification for government intervention in the form of paying subsidies to firms proposing to undertake projects that appear to meet certain conditions. These conditions were developed in detail. They were designed, in a word, to enable subsidy program administrators to distinguish efficiently between the proposed projects that both need subsidies from a firm's standpoint and deserve subsidies from society's standpoint and those which do not. Schematic consideration was also given to the various administrative and informational demands that these conditions impose upon subsidy programs, from the perspectives of both *ex ante* decision making and *ex post* evaluation.

We now take up the first of the federal subsidy programs that are examined in this study – the Enterprise Development Program (EDP). The Program is considered as an administrative entity, in terms of its stated objectives and the ways in which its administrators have, so far, gone about pursuing them. The purpose is to ascertain whether the Program has operated in a fashion that is compatible with our conceptual requirements and, if not, to determine the reasons and indicate the remedies. More specifically, the following questions are asked:

1) What are the objectives of EDP, and are they mutually consistent?

2) What are the criteria and/or decision rules that govern the awarding or denial of subsidies under the Program, and how (or upon what informational basis) are they applied?

3) Are these criteria and/or decision rules of such a nature and applied in such a way that they are likely to satisfy, to a reasonable extent, the conditions necessary to endow the Program with incrementality – at least to the firm and perhaps to the industry?

4) To what extent does the question of incrementality to the economy enter into the *modus operandi* of the Program?

5) What sort of retrospective evaluation of the Program's activities is done regularly or at least contemplated?

6) In the light of the answers to the foregoing questions, what changes in the Program's *modus operandi* are called for in order to render it more efficacious?

In addition, the Howe-McFetridge model will, with slight modification, be utilized to estimate the direction and extent of the impact that EDP subsidies have had upon the own-R&D spending of subsidized firms. This will also provide a context for some discussion of the wider problems involved in the specification of an appropriate model for this type of analysis. The Program, however, has not yet been in existence long enough to permit a meaningful retrospective evaluation of its overall impact upon the economy. Hence this particular discussion, which bears on that wider issue, is rather peripheral to the main thrust of this chapter, as embodied in the above questions. It is therefore presented separately as Appendix B. We shall begin with a brief look at two programs that preceded and either directly or indirectly led up to EDP.

The Two Principal Predecessors of EDP

The subsidization of private R&D spending by the federal government goes back at least as far as 1962, when special income tax incentives for R&D spending were introduced. These particular tax incentives expired in 1966 and were succeeded the following year by the provisions of the Industrial Research and Development Incentives Act (IRDIA).

IRDIA

Under the Industrial Research and Development Incentives Act, any taxable Canadian corporation operating in Canada was enabled to apply for a subsidy (grant) based upon its R&D spending in Canada during its most recent fiscal year. The subsidy provided for an amount equal to the sum of

a) 25 per cent of the increase in eligible current expenditures made by a corporation in Canada over the average of such expenditures in a base period consisting of the five immediately preceding years, and

b) 25 per cent of capital expenditures made by a corporation in its fiscal year for the provision of facilities to conduct scientific research and development activities in Canada. [See Department of Industry, Trade and Commerce (1978), pp. 2-3.]

Firms were originally required to submit their subsidy applications retrospectively. In 1971, a change in the regulations provided that applicants with an "acceptable record of performance under the program" could receive partial payment of their ultimate subsidy in advance. At the end of 1976, the Act was amended to preclude the payment of subsidies for R&D expenditures made after December 31, 1975. After 1967, some 9,000 applications were received from some 3,000 Canadian corporations, of which some 8,500 were approved. Subsidies amounting to $291.5 million were awarded.

The view began to develop in government circles, more or less concurrently with the advent of IRDIA, that further, more sharply focused measures were also needed. The result was the Program for the Advancement of Industrial Technology (PAIT).

PAIT

The Program for the Advancement of Industrial Technology was authorized in 1965 and assigned the following objectives and criteria, which were outlined in a report published by the Department of Industry, Trade and Commerce:

Program Objectives

> The basic purpose of the PAIT Program is to promote the growth and efficiency of Canadian manufacturing and processing industries by providing financial assistance to companies on a selective basis for the development of new or better products and processes with which to serve larger markets. Specific objectives of the Program are to:
>
> - select projects based on their sales potential and the capabilities of the applicant companies to exploit the results in a manner that will result in a net gain to Canada;
> - expand exports and reduce imports of manufactured products on a competitive basis;
> - increase the level of productivity in Canadian manufacturing industry;
> - assist companies to strengthen their operations in Canada through product specialization and rationalization;
> - improve the technological capability of Canadian manufacturing industry and reduce its dependence on foreign technology;
> - encourage both large and small companies toward innovative programs and well thought out product lines with strong future market potential;
> - encourage innovation in order to promote and exploit unique Canadian capabilities;
> - provide new employment opportunities in industry. [See IT&C (1971), pp. 1-2.]

Program Criteria

> Assistance under the Program is available to companies incorporated in Canada, to groups of companies organized as consortia, and to trade associations to the extent that they can satisfy the requirements of the Program.
>
> The fundamental requirements for PAIT support are that a new or improved product or process will result from the development project, that the project carries with it good prospects for profitable follow-on production and sales from a Canadian manufacturing base, and that the applicant company is prepared to make a substantial financial contribution to the development cost. The Department's contribution to a project is normally 50% of the approved cost.
>
> The Program's project selection criteria require objective appraisal of the merits of the development proposal and of the capabilities of the applicant company. Development proposals are appraised for innovation and for technical feasibility within time and cost constraints; the commercial aspects are appraised with respect to the needs, characteristics and size of the market, the growth of the market, tariff and non-tariff barriers to market access, the nature of competition in the market, and realistic market penetration.
>
> The capabilities of applicant companies are evaluated as to organization, facilities for follow-up exploitation, and financial resources. With regard to organization, the technical, marketing and management capabilities, and the corporate characteristics, are of special interest. [See IT&C (1971), p. 2.]

The Program was also endowed with a payback provision:

> To offset the fears of a few large companies in 1965 that implementation of such a program as PAIT might confer an unfair commercial advantage on their competition, a payback provision was incorporated into the terms of the Program according to which companies would be required to repay the PAIT contribution to the project, with interest, compounded annually, if the development was completed successfully and the results used commercially. This provision was intended to place companies with successful PAIT projects in a position comparable to those which used commercial sources of financing. [See IT&C (1971), p. 2.]

This provision, which in effect made PAIT into a conditional loan program, was seen from the outset as being potentially problematic. It was recognized as rendering the Program's conditions more stringent than those of other federal programs to promote industrial growth. In the event, industry response to the Program during the next three years was tepid.

An ensuing internal review led to the unearthing of additional drawbacks.

> A primary reason for industry's poor response to the Program was the treatment of PAIT payments to companies under the federal Income Tax Act and IRDIA, which made the financial terms and conditions of PAIT frequently less favourable from a company's standpoint than those of a commercial loan. Unlike a loan, PAIT payments had to be subtracted by a company from its R&D outlays in calculating its eligible current expenditures for a grant under IRDIA. Although repayment of PAIT contributions could be deducted by a company for tax purposes and included in applying for a grant under IRDIA, these repayments were usually not made until four or five years after the expenditures had been incurred, over which period the company in effect paid interest on the amount of these tax savings and IRDIA grants. In these circumstances it would cost a company substantially less to borrow money from a commercial source to finance a successful development project, even at a higher interest rate, than to obtain assistance under PAIT. [See IT&C (1971), p. 3.]

All this resulted, in 1970, in a series of far-reaching changes in the Program. The pay-back requirement was eliminated, save where the Program's contribution to a project had exceeded 50 per cent of its total cost. If the project produced commercially usable results for the firm, this excess was to be repayable. The results were not long in coming.

> Amendment of the Program to place it on a grant basis resulted in an immediate increase in applications for assistance. During the first year of operation on this basis, approved projects increased in number to 137 from 56 in the preceding year, and the PAIT commitment to projects approved during the year increased to $51.1 Million from $12.7 Million. [See IT&C (1971), p. 4.]

The process that produced the above changes also produced others, which apparently went into effect the following year. Essentially, these involved the extension of the definition of fundable activities to include various design-related and testing activities and various other activities intended to assess the commercial prospects of the innovation. From then until its replacement by EDP in 1977, the essential character of PAIT remained unchanged.

The foregoing information on PAIT was drawn from the annual reports prepared within the Department of Industry, Trade and Commerce. It appears that these reports constitute the bulk of the ongoing evaluations made of the Program. It is therefore useful to look at them more closely. This will enable us to consider how the Department went about its evaluation of the Program during the years it was in effect. Because it is a digression (albeit an instructive one) from the main thrust of this chapter, this discussion will be presented separately in Appendix C.

It is useful here, however, to consider briefly the objectives and criteria of the Program that were quoted above. The Program's main objective was, of course, to promote the growth and efficiency of Canadian industry. As for its eight subobjectives, they were not necessarily inconsistent with the main objective nor with one another; but neither were they necessarily consistent. The subobjective of expanding exports and reducing imports may, for example, have squared in some cases with industrial growth and efficiency and with improving the technological capability of Canadian manufacturing; but, as will be shown in the next chapter, in other cases it may not have done so. The same might also be said of the subobjectives of providing new employment opportunities in industry and of reducing dependence on foreign technology. What we have here is something of a catch-all of ostensible desiderata, with no indication of their priority status relative to one another. As for the Program's criteria, the emphasis was unmistakably on projects likely to be profitable to the subsidized firms. There is no hint of awareness of the danger of nonincrementality. That is, there is no visible concern that the Program might inadvertently (we may assume that such an effect would have been considered inadvertent) support projects that would have proceeded without support and thus would have been supported unnecessarily.

The Advent of EDP and Its Objectives

Throughout the mid-1970s, the feeling developed within the federal government that the international competitive environment was becoming progressively disadvantageous to Canada and that a review of existing industrial incentive programs, especially those under the aegis of the Department of Industry, Trade and Commerce, was called for. Apart from IRDIA and PAIT, these programs (some half dozen altogether) ranged from the general Program to Enhance Productivity (PEP), under which small subsidies were made available for productivity-improvement feasibility studies, to the industry-specific Footwear and Tanning Industries Adjustment Program (FTIAP), whereby firms in those industries became eligible for aid in adapting to the exigencies of the international competitive environment.[1] The upshot of this review, which included the commission of a report by outside consultants and a variety of other research, was the establishment, in April 1977, of the Enterprise Development Program.

The new program had two distinct aspects: loan guarantees and loans, and/or subsidies. It was intended to subsume and rationalize the administra-

Type of project	Eligible costs	Sharing ratio	Limit
Innovations: product development and/or design	Direct	75 per cent for firms with sales of less than $10 million	None
		50 per cent for firms with sales of over $10 million	None
Project exploitation (of a previously approved project)	Consulting	75 per cent for firms with sales of less than $10 million	$100,000
		50 per cent for firms with sales of over $10 million	$100,000
Productivity enhancement (determining the feasibility of the productivity development projects developed by a manufacturer)	Consulting	75 per cent for firms with sales of less than $10 million	$100,000
		50 per cent for firms with sales of over $10 million	$100,000

tion of all but one of the above-mentioned programs of the Department of Industry, Trade and Commerce. The exception – namely, the large Defence Industry Productivity Program (DIPP) continued apace; it will be discussed in the next chapter. (IRDIA perhaps qualifies as another exception, since the essential concept that it embodied – generalized tax incentives for R&D – has remained operational. Administratively, however, this concept no longer resides in the Department.) *And for the first time, apparently, the notion of incrementality was explicitly incorporated as a formal consideration among a subsidy program's objectives.* It was not anticipated that EDP would involve a higher level of outlays in the immediate future than the subsumed or replaced programs would have done in the aggregate, but it was anticipated that increases in administrative efficiency would put more, better-focused dollars into the most appropriate private hands.

At the time it was initiated, the Program's general objective was to improve the international competitiveness and productivity of Canada's secondary industry. It was also intended to focus on the small and medium-sized firms engaged in innovative activity.[2]

Before discussing the decision-making structure of the Program and the kinds of information elicited from applicants for innovation subsidies in order to substantiate decisions, it is useful to list the most relevant categories of subsidies ("contributions") made available under EDP. Of these, only the first category – product development and/or design – is quantitatively significant. The overwhelming proportion of EDP subsidies – over 90 per cent of each year's outlays – falls into this category. Our subsequent discussion of the Program is therefore confined to this type of subsidy.

The Decision-Making Mechanism of the Program

The decision-making mechanism of EDP was avowedly designed to promote the objective, *inter alia*, of avoiding (as its predecessors had allegedly failed to do) undue involvement with large firms, as well as undue dispensing of assistance to firms in Central Canada. The various boards, composed wholly or partly of members from the private sector (and usually playing only an advisory role) that had existed in relation to several of the predecessor programs were replaced by two new types of boards having full plenary powers. One of these, a central Enterprise Development Board, was to deal with proposals involving sums greater than $200,000 or smaller projects emanating from firms whose annual sales exceeded $2 million. This Board was to consist of two committees, one known as the Innovation Assistance Panel and the other as the Adjustment Assistance Panel, the former to be concerned with the granting of innovation subsidies and the latter with loan guarantees and loans. Proposals for either subsidies or loan guarantees, etc. – in amounts of less than $200,000 and emanating from firms whose annual sales were below $2 million – were to be dealt with by regional Boards. (In 1979, firms having sales below $5 million were allowed to deal with regional Boards in respect of projects below $200,000.) There were to be ten such Boards, one located in each province. All Boards were to be composed of equal numbers of private-sector and public-sector members, with the chairman drawn from the private sector.

These Boards have been making the final decisions on applications, and they have been making them on the basis of information that was supposed to be placed before them in conformity with a specific format, which will be described below. By the time an

application reaches a Board, it has already undergone a thorough vetting by officials in the Department's relevant industry-sector branch and in its corporate analysis branch. In addition to moulding applications into the form required by the Board, these branches have also had the important function of weeding out applications thought to be undeserving of support (usually by persuading firms to withdraw them). It is therefore reasonable to expect that applications that reach a Board stand quite a good chance of being accepted: in any event, they carry the endorsement of the officials who have vetted them. These officials, or some of them, attend the Board meeting at which the decision is made (no applicant representative may attend) in order to provide such supplementary information as may be required.

The Philosophy of EDP According to Its Administrators

The following extracts from the First Annual Review submitted by the Program's administrators convey their conception of the philosophy of the Program (with special reference to its subsidy aspect) and their approach to applicant firms. These extracts also give an indication of the administrators' experience with its incrementality rule for subsidies during the first two years of the Program's existence.

Operating at the Margin

The philosophy of the EDP program is to operate at the margin in order to supplement rather than to compete with or supplant private sector resources. *The objective of the program is to induce worthwhile projects to be undertaken by viable private firms which would not be undertaken by the private sector alone due to the risk inherent in the projects.* In this manner, the EDP program endeavours to influence private sector decision-makers, both credit granters and private investors, to develop viable Canadian firms which can compete in international markets.

To ensure that the Enterprise Development Boards are supporting incremental investments, i.e., those which would not have materialized without Board support, the EDP program criteria provides [sic] for a last resort test for loan insurance *and a means test, called the significant burden criterion*, for contributions . . . . The contributions available under the EDP program are directed to incremental investment through the significant burden criterion. As part of the terms and conditions for contributions, which were approved by the Treasury Board, the Boards (EDBs) must satisfy themselves that each project and its implementation represents a significant burden on the resources of the proposed recipient firm. *This complex and subjective criterion is approached by the application of a number of qualitative and quantitative tests to assist the Boards in their deliberations.* The significant burden criterion represents a major departure from the selection criteria of the previous PAIT program . . . .

As with any discriminating selection criteria, some cases of hardship have developed in the first two years of operation of EDP. *In 1978/79 a more flexible approach was developed, within the spirit of the program, to provide for exceptions to the significant burden criteria if, in the opinion of the Board and subject to Treasury Board approval, a worthwhile development project would not be undertaken in Canada without a contribution and the project represented a significant benefit to Canada.* [Emphasis added.]

The Corporate Approach

The policy of the EDP program is to rigorously analyse the viability of the project and the firm to be supported and, upon provision of the EDP support, to impose conditions as may be required to enhance the viability of the proposal. This business-oriented analysis and decision making is frequently described as the corporate approach. Under this philosophy, some proposals which technically meet the eligibility criteria of the program are declined by the Boards, if in their opinion, the project or the firm is not viable.

This approach is demanding on the applicant, the staff, and the Board members as it requires more information and analysis than is required by other approaches to industrial development.

To assist the process, contributions to engage expert consultants to develop complex proposals, to study markets, or to develop marketing strategies are frequently provided before major innovation or restructuring projects are supported. Contributions are also utilized to protect the interest of the Board in an existing project when circumstances dictate it.

Although the corporate approach is demanding and occasionally time-consuming, the success rate of projects supported under the EDP program will tend to be improved in the process and the quality of information enables the Boards to cope with more venturesome proposals. Experience has shown that this discipline is frequently in the best interests of the clients of the EDP program as well.

Monitoring

Operating in a high risk mode requires the Boards and staff to carefully monitor projects after approval. Financial statements of EDP clients are reviewed at least annually, and more frequently for insured loans. This enables the Boards to detect early signs of difficulties and to take remedial action as it is considered necessary. Technical monitoring by the Department is a continuing function for innovation projects as well. [See IT&C (1979), pp. 9-11.]

We now consider the significant-burden criterion. It, being the Program's incrementality test for subsidies, compels close attention, in terms of its inherent character, to the way in which it was intended to operate[3] and, above all, to the way in which it has so far actually operated.

	Small company		Larger company	
	($ Thousands)			
Size criteria of company				
Not more than:				
Tangible net worth	2,500		50,000	
Earnings after tax (last fiscal year)	500		7,000	
Cash flow	750		10,000	
Risk category of innovation project				
Degree of risk:	Low	High	Low	High
	(Per cent)			
Test 1				
To meet significant-burden test, 100 per cent of innovation project cost should be in the range of:				
Percentage of tangible net worth	25	10	15	10
Test 2				
To meet significant-burden test, 100 per cent of average annual project cost should be in the range of:				
Percentage of last year's cash flow	50	25	40	20
Percentage of average of last three years' cash flow	30	15	30	20

The Significant-Burden Criterion

A quite recent section (section 3) of EDP's terms and conditions for subsidies for innovation projects dealing with product development and design states that:

> . . . the Board may make a contribution to a person in respect of a project only where,
>
> (a) in the opinion of the Board, the project and the exploitation of the results thereof represents a significant burden in respect of the resources of the person; or
>
> (b) in the opinion of the Board, the project would not proceed in Canada unless the contribution is made by the Board, the project and the exploitation thereof offers significant benefit to Canada and the Treasury Board has authorized the Board to make the contribution upon the recommendation of the Board. [See IT&C (1981), p. 5.]

Section 3(b) of the foregoing is a relatively recent addition, as the earlier quotation from the First Annual Review implies. Although no firm was ever intended to be precluded from being eligible for a subsidy on grounds of size or nationality of ownership, the Program had been intended, as we have seen, to be focused upon Canadian-owned small and medium-sized firms. The feeling developed before long, however, that reliance upon Section 3(a) alone would have this precluding effect; hence, Section 3(b).

The above specific criteria were developed (and once developed, seem to have remained essentially unaltered) for the purpose of applying the significant-burden criterion to proposals for innovation subsidies.

In general, Tests 1 and 2 were intended to be applied on a consolidated basis when applicants had corporate affiliates, subject to one important exception. If the applicant was deemed to be completely autonomous and financially self-sufficient in relation to its affiliates *and* if the contemplated project was in a field unrelated to the activities of the affiliates, then the applicant was to be viewed as a separate entity. It was recognized that the decision as to the applicability of this exception would usually be a difficult and, at least in part, a rather subjective one. It was also intended that the applicant's overall financial situation and *modus operandi* would be carefully examined to assess their respective soundness. Here too, it was recognized, value judgments would have to be made with respect to a variety of matters, such as how the applicant firm's cash flow was allocated among capital formation and debt retirement, how its dividend record compared with industry norms, how its directors and officers were compensated, and the like.

The foregoing, revised version of the significant-burden concept emerged only after a great deal of internal debate had taken place within the confines of the Department. During the course of this debate, a

number of themes were aired and, although they did not, in the end, receive explicit recognition in the formulation of the concept, they undoubtedly entered into the consciousness of the officials and private Board members charged with running the Program. Their overall effect was to provide a rationale – all the more sweeping because it was never defined with precision – for subsidizing projects that failed to meet the formal criteria but that were nevertheless thought likely to advance the long-term industrial development of Canada. Most of these projects would presumably emanate from larger firms – many of them affiliates of multinational enterprises – whose resources, even when not consolidated, were such as to preclude their meeting the above quantitative criteria. Another factor that entered into the picture was the objective of inducing multinational firms to endow their Canadian subsidiaries with world mandates for certain projects. In effect, then, the significant-burden criterion emerged as but one of several factors to be considered when selecting the projects to be subsidized, although it was hardly free, as has been indicated, of important subjective elements. The others combined to provide program administrators with a wide and vaguely defined discretionary area. It will be necessary to bear this latitude in mind when we discuss a number of projects that received relatively large subsidies under the Program.

The Significant-Burden Criterion as a Test of Incrementality

Notwithstanding the foregoing qualifications of the scope of the significant-burden criterion, which have at least the potentiality for vitiating it to a considerable extent, it has remained a factor of primary importance to decision making. It is therefore worthwhile to pause at this point and offer a few comments as to its inherent capacity to serve, in the above operational form, as a test of the incrementality of a proposed project.

It is evident, to begin with, that the incrementality in question can, at best, refer only to the firm; it can have little bearing upon the project's incrementality to the industry and still less upon its incrementality to the economy. This is a limitation rather than a defect. More important reservations arise when we consider how the project and its attendant risk are viewed. To put the problem negatively, the project is not viewed in terms of the relationship between its expected private (let alone its inappropriable) benefits and its cost, as it should be. Instead, its cost is represented in relation to the firm's tangible net worth and average cash flow. This gives the issue a focus that is fundamentally misleading. Although they certainly reckon with the proportion of their present and potential resources that a given project involves, firms will generally proceed, or decline to proceed, with a project on their own, on the basis of the relationship between the project's expected benefits to themselves, however calculated, and its cost. There is no reason to assume, as this approach implicitly does, that a project that bears the stipulated relationships to the firm's tangible net worth and average cash flow is necessarily also characterized by an expected-private-benefit/cost ratio that is so unattractive as to deter the firm from proceeding without a government subsidy. These stipulated relationships are in fact independent of the project's expected-private-benefit/cost situation. They can as easily co-exist with an attractive private-profit outlook for the project as with an unattractive one. What they do is shed some (but only some) light upon the project's implications for the firm's *liquidity*, but that is a different matter altogether.

Reliance upon these tests *may* therefore draw attention to the liquidity problems of applicants but that is all it can do. This, in itself, would be a good thing; but since the prescribed solution to these problems is a subsidy, it proves in the end to be a bad thing. There is, after all, no reason why a firm's liquidity problems ought to be solved by a subsidy. (We shall return to this problem later.) To repeat, whether or not a proposal satisfies Tests 1 and 2 constitutes little or no evidence of the degree to which the applicant firm rationally perceives proceeding with the project as being in its own interests. Hence these tests have scant bearing upon the project's incrementality to the firm. The trouble is not so much that they deal inefficiently with the critical relationship between the project's expected private benefits and its cost; it is that they effectively prevent this consideration, and other relevant ones, from emerging.

An additional word is in order about the problem of determining the degree of autonomy that an applicant that is part of a larger corporate family actually has. This is bound to be a very difficult question to answer. The requirement that the project be in a field outside those of the applicant's affiliates is sensible enough, but secondary. As for the financial self-sufficiency of the applicant, this is an inherently ambiguous concept that is not, in any case, central to the issue of the project's incrementality. Presumably, certain other aspects of the applicant's autonomy, especially those involving decision making, could be evaluated by ascertaining the limits of the budgetary and technical discretion with which the applicant's management is endowed by its parent firm. This, too, has relevance. But the critical considerations determining whether the applicant would proceed with the project without subsidization remain bound up in the relationship between the project's expected private

benefits and its cost. It is upon this relationship that attention must be focused in the first instance. Other aspects, such as the applicant's financial viability and managerial capabilities, are certainly relevant to the question of whether a subsidy should be awarded, and they must be investigated. But if this investigation is conducted as a substitute for, rather than a concomitant to, the estimation of the project's expected-private-benefit/cost relationship, the Program's objective of incrementality is most unlikely to be promoted effectively.

We now turn to the raw material, so to speak, of the Boards' decisions on subsidy applications – namely, the information available to them when they decide. We consider, first, what they are supposed to receive in the way of information and the form in which they are supposed to receive it.

The Formal Informational Basis of Awarding or Denying Subsidies

The Boards are supposed to base their decisions upon a formal document entitled "Contribution Submission." It consists of two sections: one, Section A, is a two-page summary document; the other, Section B, is intended to provide more detailed information. Since it is the explicit purpose of Section B to "provide the Board with information of a scope and depth necessary to sound decision-making," it is worthwhile to consider not only what it conveys but, just as important, what it does not.

The document begins with a mainly qualitative statement of the concept of the project – its cost, scope, and benefits. This is followed by information about the project's consultant, if any, and about the history of the applicant firm, the capabilities of its key managers, and its corporate strategy. It is the next three parts of the document that are most pertinent to the approval or rejection of the application, and they are therefore quoted verbatim.

7. THE APPLICANT's PROPOSAL

1. (a) The Project

A brief paragraph describing the nature, purpose and expected benefits of the proposed project. For Product Development proposals, the technologically innovative features and the commercial applications of the end-product or end-products should also be mentioned to give a clear idea of what will be developed and why it has commercial merit.

(b) Implementation of the Project

Comment briefly on the implementation phase and associated costs.

2. Proposed Sources of Financing

This section should indicate the source and on what terms and conditions the company will obtain the funding for the project and its implementation.

8. MARKETING AND COMPETITION

Markets

- Explain briefly the basis on which it has been determined that the company can compete effectively in any proposed new or expanded markets.

- Comment on any studies, market surveys etc., made with regard to existing or new products.

- Comment on sales growth patterns, historical and forecast by product, regions, etc. for the company and the industry.

- Identify major existing or proposed customers and the present and anticipated order position.

Competition

- Comment on the company's present place in the industry in terms of market share and quality, price, etc. of products.

- Identify principal competitors and their particular strengths.

- Indicate company's anticipated market share and that of principal competitors and tie this in with the anticipated growth of the entire market. In the case of a new product or process identify factors expected to contribute to the company capturing the indicated portion of the market; i.e., the qualities of the product [sic] will give the company a competitive advantage, e.g., price, performance, reliability, simplicity, etc.

- Comment on marketing methods, i.e., does the company employ a sales force, utilize agents or jobbers?

- Comment on sales barriers – tariffs, quotas, freight costs, captive markets, subsidized competitors.

9. FINANCING

(1) Operating Results and Forecasts

Prepare a breakdown of the company's income statement and projections by following the Format.

Following the tabular presentation, the submission should contain detailed explanations of changes in the various cost categories from year to year where the changes are significant or worthy of note.

The commentary on costs should indicate the extent to which the company's past and projected financial performance has been investigated and analyzed. Comment on the adequacy of existing budgets and cost controls, indicating the reliability of past budgets. Projected percentage reductions in costs should be explained with pertinent reference to the benefits of the project.

(a) Memorandum of Project Sales/Results

Tabulate sales (domestic and export) attributable to the project and where possible expenses, cost savings and profits related to the project and its implementation for the three year forecast period.

(b) Memorandum of R&D Expenses

Tabulate historical and forecast research and development expenses. The forecast should separate ongoing and project expenses.

(2) Source and Application of Funds

This section is basically a summary of information contained in forecast and actual financial statements provided by the applicant.

(3) Working Capital

Many Contribution projects will involve companies whose working capital positions are clearly strong enough to handle all eventualities likely to arise out of a project. A simple statement of that fact with reference to the figures in section 9(2) and a tabulation of forecast working capital levels and ratios over the next three years will normally suffice to cover this subject.

In cases involving less substantial companies wherein the existing and projected working capital position is not clearly of sufficient strength to ensure that project associated costs, exploitation costs and increased demands of significantly increased sales can be handled without affecting the viability of the company, it must either be shown that there are outside sources of funding or the adequacy of the working capital position must be fully analyzed.

In this latter circumstance a detailed cash flow covering a three year period should be prepared and attached as Appendix B. The assumptions used in the cash flow will be an integral part of the Appendix.

In total, this section should confirm that present and future requirements for working capital will be satisfied on a reasonable basis, assuming the attainment of projected sales and earnings.

Comments on the Informational Format

Although the relative emphasis on its various components may leave something to be desired, the above formal informational basis for decision making on subsidy applications contains most, though certainly not all, of the elements necessary for rational judgments by the Boards. Sections 9(1)(a) and 9(1)(b) are of particular importance, since they have at least the potential capacity of facilitating a coherent evaluation of the project's expected benefits and cost to the firm. The other information postulated is also relevant. The firm obviously must possess the overall financial strength to navigate, as an entity, not only the project's developmental and implementational phases but also the period beyond. It is therefore entirely legitimate for the Boards to require assurances on that score.

Much the same is true, though to a lesser degree, of the information required on markets and competition. The Boards clearly need to have an idea of the nature of the demand for the projected product, and they also need to know about the other contenders for that demand. Although it is perhaps implicit in the format, it probably would have been desirable to require explicit information from the applicant on the probable effects of the innovation upon those competitors and, more particularly, on the probability that any of them is currently doing R&D in the same area or will be doing so in the near future. This would have been useful in regard to the questions of incrementality to the industry and the length of the innovative interval.

It should, however, be stressed that this format has only a potential, rather than actual, adequacy for the estimation of a firm's costs and private returns. In order to achieve adequacy, these future returns will need to be discounted, at an appropriate rate, to their present value. They will also need to be computed net of the project's R&D costs. This further implies that the three-year forecast period with respect to the project will, in most cases, need to be extended.

There is one area of critical importance that is not touched upon in this format nor, apparently, has it entered into either the explicit or implicit rationale of the Program. This, of course, is the area of the inappropriable benefits that are expected to be generated by the proposed project. Needless to say, this deficiency will need to be rectified – mainly, as was indicated earlier, by the professionals on the Program's administrative staff, working in close cooperation with the applicant firm. The practicalities were shown in Chapter 1 to be well within the realm of the possible.

Another important consideration that was not mentioned in the format should be noted. The various financial data pertaining to the firm's earnings and financial condition are formulated on the basis of conventional Canadian accounting practices. These practices were developed long before high, chronic inflation became a fact of life. A great deal of evidence is now available, including work by the present writer [Tarasofsky *et al.* (1981)], to the effect that the earnings of nonfinancial firms are substantially overstated when calculated on the basis of conventional methods and that the same applies to the state of their financial health. In other words, the Boards will get a seriously overoptimistic impression of the present and future viability of applicant firms from the financial data prescribed in the format if these data are not inflation-adjusted. This is a situation that is fortunately not difficult to rectify, since there are now available several alternative methods of developing inflation-adjusted accounts. For present purposes, it matters not so much which method is adopted, but that the inherently misleading conventional figures are not relied upon to any great extent.

Some Actual Cases

An effort has been made to develop something of an empirical sense of the ways in which the foregoing criteria and/or decision rules have been applied and

the informational requirements met in practice. On the assumption that the larger the project (and the Program's stakes), the more stringent the application of the criteria and the more complete the information gathered, the files of six of the largest projects supported by EDP were examined. Each project amounted to more (usually much more) than a million dollars. EDP's share in most cases represented 50 per cent of the estimated project cost. Six projects represent quite a significant proportion of the total projects in this size category. In order to preserve confidentiality, the information disclosed about these projects is confined largely to that which appears to have most influenced the thinking of EDP's administrators in making their awards.

In the case of the first project, the ultimate product was intended to serve both the domestic and the export market. Among the Canadian-controlled, recipient firm's relatively few competitors in the world is the Canadian subsidiary of a U.S. parent. One explicit purpose of the subsidy was to enable the recipient to displace those competitors, especially the Canadian one. The projections made in conjunction with the subsidy pertained not to the project but to the firm as a whole and to the division in which the project was to be undertaken. These involved operating statements, some balance sheets, and flow-of-funds statements. Rates of profit were estimated as percentages of sales. (This way of expressing rates of return proved to be quite a common characteristic of the projects reviewed.) It is interesting that the division undertaking the project was expected to earn, after the early years, higher annual rates of return on sales than the firm as a whole. The firm's debt/equity ratios were projected to be fairly low. The risk attached to the project was estimated to be in the low-to-medium range.

The second project was undertaken by a firm (established expressly for that purpose) that was owned jointly by a Canadian and a foreign firm. The Canadian partner maintained that it could not proceed with the project unaided because (1) it was in the process of writing off the costs of one of its other operations that had proven to be unprofitable; and (2) it was in the process of expanding two other operations, one in Canada and the other in Europe. Another interesting feature of this case is the fact, made apparent in the projections provided by the applicant, that EDP's subsidy was to be substantially applied, in effect, to paying off debts falling due during the following two to three years, during which time the firm expected to face a working-capital deficit. The project was thought to be subject to a risk factor in the low-to-medium range. In this case, the firm expected some early negative returns followed thereafter by quite healthy returns.

The third project, thought to be subject to a fairly high risk factor, involved an improved version of an existing product produced mainly for export. The firm is controlled abroad. The world market for the product is an oligopolistic one, and the project's success was expected to be contingent on the subsidized firm being the first one to develop and market the improved product. The projected rates of profit on sales appeared to be relatively moderate.

The fourth project was also undertaken by a foreign-controlled firm. Relatively high rates of profit on sales were projected; however, since it was decided that the project faced low risk, EDP's contribution was reduced to approximately one-third of the project's cost.

Of the remaining two projects, one was not assigned a risk category nor were its future returns projected along lines comparable to those applicable to the other projects. The significant-burden criterion, however, appears to have been met. The other project was also looked at in a rather singular fashion. The firm in question is a young, wholly-owned Canadian firm, regarded as a dynamic leader in a high-technology field. The firm has a proven track record of having used to good advantage several loans and subsidies extended to it under various predecessors of EDP. The only rate-of-return-on-sales projections that were made refer to the firm as a whole; for the project, only sales volumes were projected. These rates of return on sales were apparently regarded, with approval, as high. They seem to have added lustre to the project, since its projected sales represent a very significant proportion of the firm's total sales. The documents give the clear impression that a desire to foster the continued success of a dynamic firm in a high-technology field was an important factor in the decision to award the subsidy.

Comments on the Cases

Of the six large subsidies reviewed, it would appear that the third comes closest to meeting one (but only one) of the necessary conditions for an innovation subsidy that were set forth in Chapter 1. The project is relatively risky, and its expected rate of return – on sales, admittedly (this problem will be taken up later) – may be relatively low. It seems likely that we have here a project that was not sufficiently attractive to induce a private firm to proceed with it unaided.

Matters become vastly more ambiguous when we consider the other five cases from the perspective of our necessary conditions. In addition to the pervasive difficulty that we encountered in perceiving whether there existed the inadequate (from a private standpoint) relationship between the projects' expected

benefits and their costs that is required conceptually, we also observed that a wide variety of rationales have been adopted and goals pursued, on the part of the Board, that appear to have questionable relevance to the stated purpose of the Program.

Taking these cases in sequence, consider the first one. The Board clearly thought it inherently desirable for a Canadian-controlled firm to displace the Canadian subsidiary of a foreign firm. The subsidy was awarded in spite of the fact that the project was expected to yield a higher rate of return than the average rate earned by the firm on its overall operations. Why such a project would not have been sufficiently attractive to the firm without a subsidy is not apparent; presumably liquidity considerations played a role. Yet it is doubtful, given its projected debt/equity ratios, whether the firm would have actually suffered liquidity problems. In any case, why should liquidity assistance be rendered in the form of a subsidy?

Consider the second case. The firm claimed, and the Board accepted, that a subsidy was justified, not so much on the basis of the project's prospects, which were regarded as good, but on the basis of the firm's losses on other operations and of the costs of its expansion in other markets, both in Canada and abroad. The subsidy's most apparent purpose was to help the firm redeem debt. Neither the apparent grounds for the subsidy, nor its application to the firm's activities seem appropriate, in terms of the efficient use of tax revenues.

In the fourth case, the Board was obviously uncertain about the validity of the project's claim for support, given its apparently favourable, relatively low-risk prospects. Is this justifiable uncertainty resolved satisfactorily by reducing the percentage of the project's cost that it was willing to subsidize?

As for the fifth case, here too we have a situation where liquidity considerations, rather than the inadequacy of the project's risk-adjusted prospects, may have determined the awarding of the subsidy. Similar considerations also apply to the sixth case, augmented by the desire on the part of the Board to foster the growth of an already-dynamic firm in a high-technology field.

As was suggested above, and without prejudice to the legitimacy of other possible forms of assistance, it is difficult to invoke either the Program's ostensible *raison d'être*, with regard to subsidies or our conceptually necessary conditions to justify the subsidization of those particular projects. While it may well have been true, at least in some cases, that the firms would have experienced difficulty in raising the funds necessary to proceed with the projects, there exist strong grounds for believing that a nonsubsidy type of government assistance would have been more efficient from society's standpoint.

There are further general comments to be made about the fashion in which the Program has been administered, on the basis of these, as well as several other,[4] cases. These would perhaps be more useful if made in a context concerned with how the Program (and others of a similar nature) could be more appropriately devised and operated. Such a context is developed in the following section.

Possible Improvements in the Structure and Administration of EDP

The objective and focus of the subsidy side of the Program seem to represent a major improvement (from the standpoint of coherence and consistency) over the collection of desiderata that has usually been assigned to these kinds of programs.[5] But, as is illustrated by the above cases, this improvement has tended in practice to be more apparent than real. We have seen how such considerations as, for example, an increase in the market share of Canadian-controlled firms, at the expense of Canadian subsidiaries of foreign-controlled firms, or the fostering of the continued growth of a Canadian-controlled firm in a high technology field have entered into the motivations of the Board. The formal objective of EDP – the objective assigned to it by the legislators, be it recalled – is to enhance the international competitiveness and productivity performance of the Canadian manufacturing and processing sector. There is very little *a priori* reason to believe that endowing a Canadian-controlled firm with a competitive advantage over another Canadian firm, simply because the latter is controlled by citizens of another country, will promote that objective. Nor is it apparent, in principle, that this objective will be advanced by further strengthening an already rapidly growing firm in an industry deemed to be "high technology." To say this, is not of course to disparage the desirability of Canadian ownership, or at least the control, of firms operating in Canada, any more than it is to deny that thriving high-technology industries are desirable. But what is at issue here is the shifting, in an arbitrary fashion, of resources, in the form of government-generated largesse, in directions that have not been sanctioned, either by market forces or (explicitly) by the legislators. Even if evidence existed to indicate that foreign-controlled firms are inherently less innovative than their Canadian-controlled counterparts, it would not necessarily follow that subsidies to the latter (which are already more innovative) are the best means of dealing with the problem. Thus, as far as EDP (as currently formulated) is concerned, the following alternative should be considered: factors such as the nationality of the parties controlling firms

or such as the relative technological level of industries should cease to qualify as reasons for support or displacement by means of subsidies under the Program or else the mandate of that side of the Program should be explicitly changed accordingly.

The use of the subsidy side of the Program, rather than its loan insurance and/or loan side, to assist firms with current or potential liquidity shortages presents yet another problem. As currently constituted, the latter side of EDP serves, and was formally intended to serve, the goal of enabling firms to reorganize their operations on a more efficient basis; in other words, it is firm-oriented rather than project-oriented. It is conceivable that the Board has felt constrained, under its present mandate, from availing itself of this side of the Program to provide the liquidity required for specific projects and has therefore resorted to the subsidy side. But this is clearly a second-best solution, since the economic rationale of a subsidy is quite different from that of a loan guarantee or loan. The former should serve the purpose of closing the gap between a project's expected private benefits and its cost, while the latter should be intended to fill a credit gap. This latter purpose is expressly acknowledged in the above-mentioned reference by the Program's administrators to the "last-resort" character of the loan insurance and/or loan side of the Program.

The overriding question, however, is whether it is possible, without undue cost or difficulty on the part of either the government or the applicant firms, to administer the subsidy side of the Program in such a way as to ensure, to a reasonable degree, that the subsidies awarded conform to the necessary conditions specified in Chapter 1. Put another way (and bearing in mind the accounting methods commonly adopted by firms) is it feasible, under a program such as the subsidy side of EDP, to calculate the expected returns to an applicant firm from a given project, as well as its cost, so as to confine subsidies to situations where the present value of the latter exceeds that of the former and to amounts equal to that excess?

As was argued in the preceding chapter, this question can be answered in the affirmative. The stream of future benefits that a firm may expect to derive from a given project is the residual that remains after the post-R&D costs are deducted from the stream of sales revenues generated by the future output that is expected to flow from the completed and implemented project. These post-R&D costs consist of the relatively fixed implementation costs that will need to be incurred to make production possible after the completion of the project, plus the usual variable costs associated with production. All of these figures can be estimated – in fact, they are estimated routinely[6] – for the requisite number of years ahead, so as to allow discounting to a present value to be set against that of the project's R&D costs. That will determine whether (and, if so, to what extent) a subsidy is needed.

Choosing the appropriate rate of discount presents a problem, as will be recalled from the earlier discussion of how to treat risk when a project is government-financed, wholly or partly. Regardless of how that issue is resolved, we still must know the firm's opportunity cost. This figure is available, though in average rather than in marginal terms, from the firm's financial statements, in the form of the rate of return that it earns each year on its capital. Averaging these annual rates of return over the years projected would give the rate of discount to be applied to the appropriate proportion of the stream of the project's benefits. Granted that this, being an average rate, is not the theoretically ideal rate (a marginal rate would be better, since the project is marginal by definition) it will generally be good enough for practical purposes because, for many firms, marginal rates of return are probably fairly constant over a wide range of projects.

As was seen above when the case studies were discussed, both the applicant firms and EDP's administrators tend to project the firm's rates of return (on the project as well as on its overall operations) in terms of sales rather than capital, as our theory requires. Can this type of indicator serve as an adequate guide in determining whether (and, if so, to what extent) the project needs subsidization? It would seem that the answer to this question is, on the whole, negative. For one thing, the capital/output and output/sales ratios – and hence the capital/sales ratios – of the various products produced by a multiproduct firm can vary substantially, even if the products serve much the same market. Consequently, the ratios applicable to the various products can present quite a misleading picture of the relative return on capital earned by these products. For another thing, even if, when the rate of return on the sales anticipated from a given project is expected to be less than the firm's average rate of return on all of its sales, it could legitimately be inferred that the firm would not wish to proceed with the project without a subsidy, this might not clearly imply the appropriate size of the subsidy, as would the decision rule that we have postulated.

In summary, it can be said than an essential part of our decision rule for subsidies – namely, that the risk-adjusted private benefits from the project must be less than the project's cost – can be made operational without undue difficulty. This means, of course, that the significant-burden criterion will have to be abandoned or at least relegated to a secondary role,

since it obscures, rather than illuminates, one of the central questions that program administrators must address in dealing with subsidy applications.

As for the other aspect of our decision rule – which requires that the project's inappropriable benefits exceed the subsidy plus its various costs – the most important thing is for program administrators to begin to accept firmly that these social benefits are every bit as relevant to sound decision making as the project's private returns and costs. Given this firm acceptance, the practical measurement problems in estimating the project's inappropriable benefits assume their proper proportions – challenging but not at all insuperable, as was shown by the Griliches-Mansfield precedents discussed in the preceding chapter. The emphasis must, of course, be on social benefits to *Canadians*. This implies that, instead of the export potentialities of subsidized projects being viewed uncritically and enthusiastically, they might more usefully be viewed along the lines suggested in that chapter.

But we now know that more than this is required before a subsidy program can be regarded as efficacious. The foregoing may suffice to ensure that a proposed project is incremental to the firm, but it can do no more than that. The project must also be incremental to the industry and, ultimately, must generate net social benefits to society. As was indicated above, the present informational format contains a few references that could shed a certain light on the project's incrementality to the industry. This, however, is no substitute for an explicit recognition that this dimension of incrementality must be examined in its own right. Here, too, it is likely that once the necessary recognition has taken place the practicalities will turn out to be quite manageable. Much the same can be said with respect to the overarching dimension of incrementality to the economy. On the assumption (which will need to be validated in due course) that the social opportunity cost of the total investment forgone because of the tax-subsidy transfer is negligible, the only additional factors that program administrators need consider are the various costs involved in the transfer. These, as was shown in Chapter 1, are far from negligible. Once again, the important hurdle is perceptual in nature: when it is surmounted, the practicalities are manageable.

It was noted earlier that EDP administrators have, from the outset, included the monitoring of subsidized projects among their responsibilities. This responsibility, however, has been conceived in quite narrow terms, being confined mainly to the technical and cost-control aspects of the project as it evolved through the various stages of the R&D process. There was, until recently, little or no recognition of the need to track projects through their production-sales phases so as to measure their ultimate economic effects. There is reason to believe, however, on the basis of discussions with various officials at the Department of Industry, Trade and Commerce, that this narrow conception is beginning to give way to a more comprehensive one. This process has not yet crystallized in formalized procedures, perhaps because the Department has been undergoing a far-reaching reorganization; thus it is impossible to comment in a substantive way on the adequacy of the new approach. It must be emphasized, however, that unless due, practical cognizance is taken of the phenomenon of inappropriable benefits (something that, apparently, has not yet occurred), the new approach will still fall critically short of what is required to permit a proper assessment of the retrospective efficaciousness of the Program. Fortunately, EDP is still young, so it will take a few more years before significant numbers of nonfailed subsidized projects complete their production-sales cycles and thereby become eligible for retrospective evaluation. Given adequate progress on the conceptual front, there is therefore time for workable mechanisms to be put in place before they are needed.

Summary

As we contemplate in this and the following chapters, government subsidy programs that are designed to foster specific innovations, as exemplified at the moment by the subsidy side of EDP, our situation is, in a sense, the inverse of Dr. Samuel Johnson's when he contemplated women preachers. We do not ask whether a conceptually valid case can be made for this kind of government activity; we saw in the previous chapter that it is entirely possible. Instead, we ask explicitly, now with respect to EDP, whether that Program is being administered in a fashion that is likely to meet the requirements of that case to a satisfactory extent. And should it be found that it is not being so administered, we ask the further question whether changes can be prescribed in the way the Program operates that would hold out better prospects for success.

To these ends, EDP was set out in some detail – in terms of the objectives assigned to it by the legislators, of its decision-making process, of the philosophy that animates its decision makers, and of the information available to them when they decide. An attempt was then made to develop some empirical insight into how adequately the Program has been meeting the theoretical requirements that such a program must meet if it is to accomplish its purpose of bringing about a higher level of socially desirable innovative activity than would otherwise occur. This

was done by reviewing several of the largest subsidies awarded thus far under EDP, on the assumption that these best exemplify the workings of the Program and the intentions of its administrators.

A total of six cases was reviewed, and it was found that in all but one of them the information available to the decision makers was unlikely to imply the sort of adverse relationship between the project's expected private benefits and its cost that is necessary to meet one of the essential theoretical justifications of a subsidy. Nor was it found that the decision makers believed that such a relationship existed or, indeed, that they would have wanted it to exist. What was found instead was an apparent reliance upon other reasons for awarding a subsidy. These included alleviating applicants' liquidity problems, displacing a foreign-owned Canadian firm, and fostering further growth of a dynamic firm in a high-technology industry.

Whatever the legitimacy of the claims for some form of government assistance inherent in such considerations (and it is not apparent that there is any, except perhaps in the case of liquidity problems), it is difficult to accept them as justifications for subsidies. It has been concluded, therefore, that those five subsidized projects (and all others whose justifications were similar) would probably have been pursued by their respective firms without the subsidies or that the subsidies did not constitute the most efficient type of assistance that the government might have rendered in such cases. One factor that contributed importantly to those regrettable results was the test employed by the Program's administrators to determine whether the applicants were likely to proceed with their projects if the subsidies were not awarded – namely, the so-called significant-burden criterion. This criterion is reasonable (and relevant) as a measure of the proportion of an applicant's overall resources that is placed at risk by a project; it is not, however, indicative (as a proper test of a project's incrementality to a firm must be) of the relationship between the project's expected private benefits and its cost.

One could go a long way towards examining that relationship by means of the Program's present information system, once certain specified changes have been made to it. The most striking administrative shortcoming lies elsewhere though. Reflecting a conceptual inadequacy, it consists of the failure to recognize the relevance (and to provide for the projection) of the proposed project's inappropriable benefits. Given the rectification of that conceptual inadequacy, the system could be adapted fairly readily to provide the necessary estimates. This would provide the critical complement to the relationship between the project's private benefits and its cost. While the latter relationship served to establish the objective need for the subsidy, as well as its optimal amount, an estimation of the project's inappropriable benefits would have served as the basis for determining whether the subsidy and its associated costs were likely to advance the interests of society.

The Program's information system is also in need of augmentation with respect to establishing whether the proposed project is likely to be incremental to the industry. This, as was indicated in Chapter 1, will usually be a relatively minor exercise. The important thing is that program administrators should be required to address the issue explicitly. Similar considerations also apply to the costs involved in the tax-subsidy transfer. Average costs per dollar of subsidy paid, calculated on the basis of previous years' experience, could be estimated along the lines outlined in Chapter 1, or along analogous lines. These estimates would be applied to specific proposed projects, together with the other project-specific data that have been specified.

Finally, an adequate monitoring system for subsidized projects must be installed, to form part of a comprehensive, retrospective evaluation system that must also be developed. Developing and maintaining such a system is a fairly elaborate and complex business, as the schematic discussion in Chapter 1 demonstrates, but it is an indispensable element of an efficiently administered subsidy program.

3 The Defence Industry Productivity Program

The line of argument developed in this chapter differs fundamentally from that of the preceding one. There, although various grounds emerged for criticism of the ways in which EDP was mandated and administered, there was no reason to question the Program's fundamental project-specific focus. That, as will be seen shortly, is not the case where the Defence Industry Productivity Program (DIPP) is concerned. Its two basic orientations (defence production and exports) combine to require a different focus – namely, the firm – and thus different criteria than were appropriate for EDP. This judgment follows from an analysis of the questions of how and to what degree the inappropriable benefits of for-export innovations redound to domestic consumers. These are questions, however, that never seem to have been considered by the policy and decision makers concerned with DIPP over its relatively long history, almost certainly because the very concept of inappropriable benefits (in any of its various guises) was neither recognized nor reckoned with. The Program has, from the start, been envisaged and operated in the pursuit of different desiderata That, of course, is not to suggest that the concept was recognized or reckoned with in respect to EDP either; there is no evidence that it was. But it still proved possible to justify EDP's project-specific focus while assigning to the concept its critical role – something that is far more difficult to do in the case of DIPP.

The Structure of the Chapter

Because of the foregoing, this chapter is divided into two distinct parts. Part 1 begins with a very brief description of DIPP's origin and continues with a discussion of some of the peculiarities of the Canadian defence production situation. Its main contents, however, are concerned with whether the analysis appropriate for a project-specific subsidy program, such as EDP, can also be extended to a program such as DIPP. The question is ultimately answered in the negative, but it is also found that the Program retains a basic *raison d'être*, provided it is refocused from the project to the firm. The rest of this Part concerns some of the implications of such a focus.

In Part 2, DIPP is considered in its own terms (as though its project-specific focus were valid) but in a fashion that is only partly analogous to that in which EDP was considered. Like EDP's, DIPP's mandate and information system(s) are described; and, again as with EDP, various DIPP cases are discussed. Whereas the outcomes of the EDP cases inevitably lay in the future, given the newness of the Program, however, the DIPP cases are all cases whose outcomes are largely known. This naturally broadens the area of discussion, as does another factor that did not apply to EDP. Fairly recently, a firm of outside consultants was engaged to conduct an evaluation of DIPP and to make recommendations for such changes as were thought necessary. This was but the latest of a series of such exercises performed in relation to the Program. Broad, but important, use is made of the material generated in connection with that evaluation.

Part 1

Background of the Program

DIPP was introduced in 1959, when Canada and the United States entered into an agreement on the sharing of defence production. Meeting peacetime defence needs by sharing production with allies was a new approach for Canada, which had hitherto attempted to develop domestically most, if not all, of the matériel required for her defence. The rapid rate of technological change in the field of military equipment during the postwar period, with its attendant implications of cost and sophistication, made it increasingly impractical for a country with small armed forces, such as Canada, to go it alone. This process culminated in 1959 with the cancellation by the Canadian government of the Avro Arrow aircraft. That, in turn, led to the agreement with the United States. Since then, Canada has entered into analogous development-sharing agreements with the United Kingdom, France, the Netherlands, Italy, Sweden, Germany, and Norway.

The Program was considered necessary because Canadian firms were having difficulty competing with U.S. firms, which, in addition to operating in a much larger market, had access to a variety of advantages vis-à-vis the U.S. defence authorities. In order to enable Canadian firms to compete with their U.S. counterparts, assistance was made available to them under the Program for research and development of new products and for capital formation. The overall objective of the Program, as well as the nature of the

assistance provided and the criteria applied, has remained much the same over the years. It is described in detail below. For the moment, suffice it to say that the Program has, from the outset, aimed to develop the capability of Canadian industry to export both defence matériel and related civil products.

Problems of Evaluating Export-Oriented, Defence-Related Economic Programs

The nature, objective, and longevity of the Program are all significantly different from those of, say, EDP and thus require analytical and evaluative approaches that are correspondingly different. To begin with, defence policy and the production of defence matériel inherently involve considerations that transcend those relating to industrial policy in its "ordinary" sense. Few goods more closely resemble pure public goods than does defence – the end result of defence production activity. That is to say, the externalities associated with defence and, therefore, with defence production are both pervasive and difficult to specify and quantify for the purpose of determining optimal output, pricing, and cost allocation. Matters become still more complicated when Canada's severely limited capacity to provide for her overall defence needs from her own resources, in this era, is considered (a situation that is, of course, by no means unique to Canada). This limited capacity and the exigencies of geography necessarily mean that she must depend upon allies, notably the United States – a dependence that has its own peculiar and complex implications. In other words, Canada must co-ordinate her defence and defence production activities with those of the United States and other allies. That need, however, is multilateral and therefore entails not only constraints but opportunities as well.

Even if those considerations did not arise, DIPP's main orientation towards exports would have major analytical importance. The implications of that orientation will therefore be considered under separate cover, in the following section.

It must also be remembered that Canada is a democratic country, in which government actions in most (if not all) spheres (certainly a significant part of the defence production sphere) take place within the view of a sophisticated and well-informed political opposition and electorate. The former is in a position to criticize those actions as vociferously as it likes; while the latter, as our governments well know, has the last word as to the degree to which those actions are regarded as being in the country's best interests. This last caveat, however, has its limitations. Obviously it cannot be taken to mean, for example, that each and every allocation of government resources to defence production was an optimal one simply because it has not been repudiated by the electorate. The electorate does not pass judgment upon individual government measures; it makes an overall judgment at election time about the past and prospective performance of governments in their many functions. This broad judgment is composed of a highly complex and inchoate mixture of favourable and unfavourable evaluations with respect to numerous specific issues. In the nature of things, and especially in peacetime, the factors involved in defence production probably do not loom large in the public mind, except perhaps when large-scale and well-publicized decisions must be made. This situation is not necessarily an altogether undesirable one, however. Paradoxically, the sensitivity inherent in many defence production decisions may require withholding from the public, in its own best interests, information essential to rational judgments. This paradox presents an additional challenge in its own right: that, too, will be discussed below.

Accordingly, when considering the administration and evaluation of DIPP, we do not possess a conceptual framework that is quite so tidy and coherent as the one available for EDP. This does not mean that DIPP cannot be administered efficiently or evaluated meaningfully. It means that the Program must be operated in a different way from EDP-type programs and on the basis of different criteria. It must also be evaluated differently.

The Inappropriable Benefits Generated by Exports

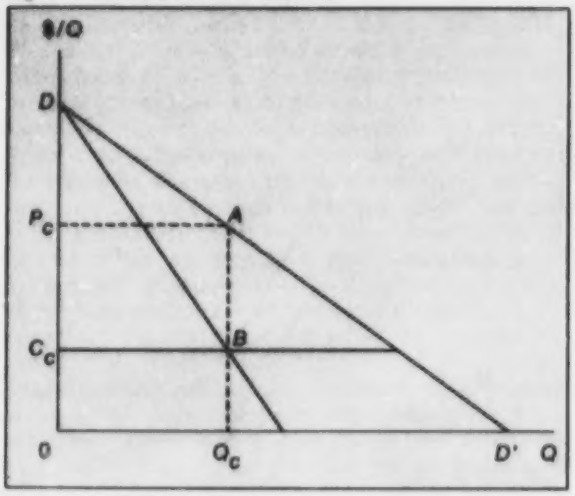
Once again, it is useful to begin with McFetridge. His model presents the following two, essentially polar, situations, the first of which is depicted in Figure 3-1.

The first situation involves a product innovation *Y*, produced by a monopolist. This monopolist maximizes profits by producing OQ_C units of *Y* per period – a level of output that generates per-period inappropriable benefits (consumers' surplus) equal to area DAP_C. McFetridge goes on to make the following important statement [p. 46]:

> If the same output were exported at price P_C, the resulting foreign currency earnings would be sufficient to purchase imports, valued at P_CAQ_CO in domestic funds. *Consumers' surplus on these imports should, on average, amount to* DAP_C *per period.* [Emphasis added.]

Figure 3-1

Total Consumers' Surplus Produced by a Product Innovation



SOURCE McFetridge (1977).

If one accepted the validity of this view of the domestic inappropriable benefits gained from the innovation, one could proceed to develop a case for subsidizing it, if it could also be shown that the innovator's private returns were inadequate to enable him to proceed with the innovation. The critical question for our present purposes, however, is whether the domestic inappropriable benefits may confidently be specified in the above on-average terms. It will be argued forthwith that they may not.

McFetridge's second situation was, in essence, presented at the start of Chapter 1, and depicted in Figure 1-1. There, a prospective process innovation in a competitive market promised to bring no return to the innovator – a prospect that effectively precluded its emergence. It was upon its capability to enable society (implicitly domestic society) to garner the inappropriable benefits of the innovation that the case for a subsidy depended fundamentally, there and subsequently. In the present context, where the product is to be exported in its entirety, under competitive conditions, the situation with regard to a subsidy, according to McFetridge, is very different indeed. Here, all of the inappropriable benefits would go to foreigners (no mention is made of imports); so, clearly, a subsidy cannot be justified.

McFetridge's two cases (which apply equally to process or product innovations) serve to convey the fact that once foreigners are designated as the only, or the main, consumers of the innovation's ultimate product, matters become much more complicated than when only domestic consumers are involved. In both cases, those who pay the subsidy in the end – namely, the domestic taxpayers – receive their compensation in the form of the imports that the subsidized exports eventually finance. In the first case, McFetridge implicitly suggests that the imports may well suffice to generate enough domestic inappropriable benefits to justify the subsidy; in the second case, he seems to imply that the imports cannot accomplish this. The crucial distinction between the two cases lies, of course, in the fact that the innovator enjoys the prerogatives of the (non-price-discriminating) monopolist in the former but is entirely devoid of them in the latter. To this, however, there should be added the further consideration that McFetridge's notion – that the domestic inappropriable benefits gained from the imports financed by the exports will, on average, equal those which would have been derived had the innovative product been consumed domestically – is decidedly questionable. The per-period consumers' surplus that his monopolist-innovator generates, represented in Figure 3-1 by area DAP_C, is determined by the particular demand and cost curves that pertain to the product in question. The "compensating" consumers' surplus that Canadians will receive if this production is entirely exported is the aggregate of the separate amounts of consumers' surplus that they will receive from the myriad of goods whose importation into Canada is indirectly financed by those exports. Each of these individual amounts is itself determined by its own international market conditions, which are bound to vary greatly from the highly competitive to the entirely monopolistic. There will therefore exist corresponding variations in the amounts of consumers' surplus that accrue to the consumers in importing countries – variations that will be further influenced by the vagaries of the relevant foreign-exchange situations. It is impossible to generalize as to how the aggregate in any specific case is likely to compare with the equivalent of area DAP_C. It will exceed this area in some cases and fall short of it in others; but there is no reason to expect equality between them, on average.

It is true that an innovation involving an export commodity, being an innovation, is likely to endow the exporter with at least some monopoly power, at least for a time. It is also possible, but perhaps less likely, that this degree of monopoly power will exceed that possessed by some (and perhaps quite a few) of the foreign suppliers of the associated imports. But that will certainly not be true of all such foreign suppliers. In addition, the possibility exists, as was indicated in Chapter 1, that the inappropriable

benefits generated by an innovative commodity may generally exceed those generated by "ordinary" commodities. If, in international trade, the former is exported in exchange for the latter under, say, equivalent competitive conditions, this would tend to imply that the inappropriable benefits exported will exceed those imported.

The relevant factors can be conceptualized rather more rigorously by considering the two situations depicted in Figures 3-2 and 3-3. The basic situation, which involves the effects of an unsubsidized innovation, be it process or product, is set out in Figure 3-2. The economic entity in question is a country. It has a given endowment of productive resources that is capable of being devoted, under given technical conditions, to the production of two alternative sets of commodities – importable commodities and exportable commodities.

Let *AB* represent the production-possibility frontier, and let *CD* represent the pre-innovation price line, whose slope reflects the prices of importables relative to those of exportables. These functions produce a pre-innovation equilibrium, where society's welfare is maximized at *J*, which lies on the highest attainable indifference curve. Importables are produced domestically to the extent of OI_0 and imported to the extent of I_0I_1. Exportables are produced domestically to the extent of OE_0 and exported to the extent of E_0E_1. The advent of the innovation in the realm of the exportables produces a new production-possibility frontier, indicated hypothetically by the broken curve *A'B* (*A'* > *A*). The new price line's slope is indeterminate, except that it will be either equal to or greater than that of *CD* (probably the latter), since the innovation will usually cause the relative price of exportables to fall, however slightly. This renders indeterminate the relative position of the tangency of the new price line with an indifference curve, but here, too, the weight of probability can be suggested. Although it is conceivable that the new price line's slope will be steep enough to touch *A'B* at a point that implies a tangency with an indifference curve that is inferior to *J*, that is an unlikely outcome. In most cases the new tangency will be superior to *J* – i.e., it will lie on a higher indifference curve. The primary reason for this expectation is the fact that the new production-possibility frontier converges with the old one at *B*; otherwise, it lies to the right of it.

Figure 3-2

Welfare Effects of an Unsubsidized For-Export Innovation

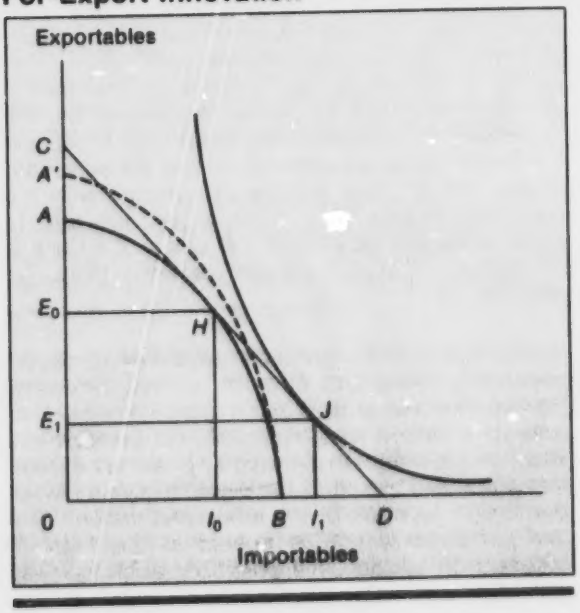
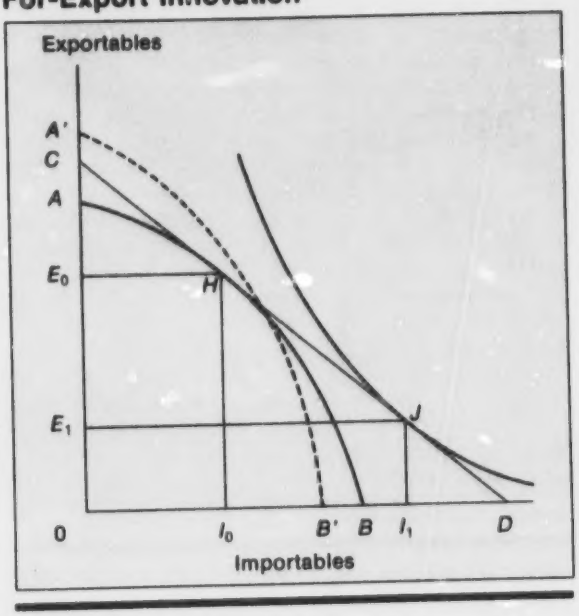


Figure 3-3

Welfare Effects of a Subsidized For-Export Innovation



This comforting feature is not available in the case of a subsidized innovation, whose implications are depicted in Figure 3-3. Here the new production-possibility frontier *A'B'* must intersect with *AB*

($B' < B$). That is due, first, to the subsidy, which transfers resources from importables to exportables, and, second, to the fact that the transfer involves substantial costs in its own right. The slope conditions of the new price line are, of course, the same as those in the unsubsidized case; however, the fact that $B' < B$ in the present case means that we cannot be nearly so confident that the subsidized innovation will produce a tangency solution superior to *J*. There now exists far more "room" for the opposite outcome. There also exists another reason why an innovation that will leave Canadian society worse off rather than better off stands a much better chance of emerging in the subsidized case than in the unsubsidized one. It is reasonable to expect, in the latter case, that inadequate inappropriable returns to Canadian society are also accompanied by inadequate private returns to the innovative firm in whose province the decision to proceed with the innovation, after all, solely resides. Hence the innovation is unlikely to emerge. This expectation is much less plausible in the subsidized case, since it is, or should be, the express purpose of the subsidy to offset any inadequacy of private returns. Thus the subsidy serves effectively to eliminate any reluctance to proceed on the part of the firm, thereby serving Canadian society badly.

The main, though not the only, implication of the foregoing discussion is this: even if all the effects of the export subsidy were satisfactorily estimable *a priori*, there is still a fair chance that a given subsidy would result in Canadians being worse off than before. The fact is, however, that those effects – especially the inappropriable benefits that Canadians would derive from the corresponding imports – are not satisfactorily estimable; there are far too many import commodities involved. These two considerations together ought to constitute a powerful inhibition to any impulse to subsidize. We require, be it recalled, that a for-export innovation subsidy (if it is to serve Canadian society) generate enough domestic inappropriable benefits to exceed the sum of the subsidy and the costs of delivering it. We have very good reason to believe that these costs will be high, perhaps almost equal to the subsidy itself. When there is a distinct risk that the overall transaction will, in the end, render foreigners better off and Canadians worse off, and since, in any case, it is practically impossible to do the required arithmetic satisfactorily, prudence dictates the conservative judgment that paying a subsidy is probably not, generally speaking, a good idea. Does this mean that a program like DIPP is unwarranted? It does not, although it does have important implications for the focus and *modus operandi* of the Program.

A negative conclusion about the Program's *raison d'être* need not be drawn, because DIPP, export-oriented though it is, operates in the realm of defence production and thus in that of defence and national security. It is well recognized that defence, like the output of infant industries, qualifies as an exception to the frown that economists generally tend to cast upon the subsidization of goods produced for export.[1]

The world being what it is and always has been, a nation's preservation of its political autonomy is inseparable from its maintenance of a credible capability of self-defence. When that nation is industrialized like Canada, this probably also implies that it must have a certain domestic capability of producing defence matériel. If the development and preservation of this latter capability requires subsidization, so be it. These postulates collectively provide the basic justification, though not the necessity in any particular instance, for the payment of subsidies to producers of defence-related commodities. When, as is true of a country like Canada, there is also a need to coordinate with, and adapt to, the defence activities of allies (as they are, to some degree, similarly obliged), this means that subsidies for the production of defence-related export commodities may be appropriate. It must, however, be emphasized that this appropriateness derives from the defence-related character of the commodities, not from the fact that they are to be exported.

The Objective of Defence-Production Subsidies and How It Might be Pursued

The foregoing serves implicitly to redefine the fundamental purpose, and hence the character, of the subsidy policy. The justification for subsidies to producers of defence matériel or related civilian commodities is now seen to lie in the need to preserve in Canada a certain industrial capability of producing military equipment. This renders the *firms* that actually or potentially embody that capability the focal points of the government's interest, rather than any particular *projects* that they might contemplate, and it renders still less pertinent the question of whether these projects involve exports or domestic consumption. The government's objective is, in a word, to ensure that the firms in question continue to exist as going concerns – engaged, broadly speaking, in their present types of activity.

The issues involved in pursuing this objective are too numerous and complex to be discussed adequately within a single chapter of a study that is concerned, for the most part, with other matters. The most that can be attempted here is to identify some of the major issues and offer a few very cursory ideas pertaining to them.

If a given privately owned firm, operating in a market economy, is to remain voluntarily in a given broad field of activity, it must earn enough to cover its opportunity cost. Put another way, its average rate of return on capital must at least equal the highest rate of return that it could earn from alternative pursuits. If, therefore, the government, in contemplating a private firm operating in the defence production field, deems it to be in the national interest for that firm to remain there, at an appropriate scale,[2] then its policy must ensure that the firm's rate of return on capital is sufficient to accomplish that objective. That is the first, but not the only, basic consideration that policy makers must address. Another is the challenge of dealing with the various potentially perverse incentives that an assured, adequate rate of return is capable of providing a firm's ownership and management. And a third consists of the set of problems arising from the fact that the activities that comprise defence production, unlike those involved in the production of most consumer goods, often have an informational sensitivity that precludes exposing them to public scrutiny.

Ensuring that the firm at least earns its opportunity cost of remaining in the defence production field is essentially a matter of doing the sums accurately. The factors of production that go into producing most types of defence equipment are, for the most part, readily adaptable to a variety of civilian pursuits – in electronics, in transportation, and in other easily identifiable areas. Enough of the firms in these fields are large, public corporations that publish their financial statements, so it would not be difficult for the government to ascertain the relevant average rates of return on capital that obtain during any given interval.[3] The second consideration – namely, the existence of potentially perverse incentives – can only be noted here. The specification of all the arrangements needed to ensure that people will strive for efficiency (in their own interests, as well as those of society) when society underwrites the risks could entail a full-length study in itself. Suffice it to say, therefore, that appropriate government participation in a firm's management will be required, whether that participation be direct or indirect.

The third consideration is endemic in the activity of producing military equipment rather than in the subsidization of that activity. The critical question is how to reconcile the rights of citizens-taxpayers with their best interests. This type of problem is probably peculiar to the defence production industry. It does not arise, for example, with respect to universities or hospitals – two other cases where subsidization is often both necessary and justifiable. The reason that it does not arise in those areas is that it may plausibly be assumed in a democratic society that the taxpayer (who pays the subsidies) is competent, in his capacity as a voter, to assess retroactively their appropriateness. This taxpayer-voter is also the consumer – in quite a palpable sense – of the educational and health care services that these institutions provide. He is therefore in a position to make a reasonably informed, broad judgment as to the adequacy of both the quantity and quality of those services. In other words, he is capable, within limits, of intelligently deciding whether or not he is getting his money's worth.

The same cannot be said with comparable confidence of the taxpayer-voter's situation *vis-à-vis* defence production subsidies. Granted that, here, too, he is the ultimate consumer of the resulting defence "services" – though a consumer in a distinctly more attenuated sense than he is in the case of educational or health care services – but that is not the main difficulty. The problem is his ability (or inability) to make an informed judgment as to the validity of the subsidies paid. Whereas the taxpayer-voter is a layman with respect to the educational and health care services that he consumes and subsidizes (especially with respect to the latter), that is merely a technical limitation – not one consciously and deliberately imposed by either the government or the suppliers of the services. The situation is very different where national defence is concerned – where what is made known to the taxpaying-voting public must perforce also, and immediately, be made known to the very powers against whom national defence is necessary. Hence we have the paradoxical fact that the defence of society compels the withholding from its members of a good deal of the information that they would need in order to make a sound judgment as to how effectively and efficiently the resources devoted to that purpose are being deployed. Clearly, some intermediate mechanism is called for – one that could safely be entrusted with all the relevant information. Its function would be to scrutinize that information from the standpoint of a mature citizenry that accepted the burdens of defence but that was also determined to get full value for its money. One possibility that comes to mind is that of a multiparty parliamentary committee, endowed with adequate technical resources. Another possibility is a committee, similarly technically endowed, composed of carefully selected private citizens, which would be responsible to Parliament. A third possibility, of course, is some combination of the first two.

Part 2

The Program's Objective and Eligibility Criteria

DIPP's overall objective and the criteria by which a given project's eligibility for assistance is determined have remained essentially unaltered since the Program's inception. A recent formulation of the objective and the criteria [Department of Industry, Trade and Commerce (1977), pp. 1-2] reads as follows:

> The objective of the DIP Program is to develop and sustain the technological capability of the Canadian defence industry for the purpose of generating economically viable defence exports and related civil exports arising from that capability:
>
> (a) by supporting selected development projects;
>
> (b) by paying one half of the cost of acquisition of new advanced equipment required for plant modernization; and
>
> (c) by supporting the establishment of production capability and qualified sources for production of component parts and materials.
>
> In keeping with the Department's roles of promoting export sales and viable industrial growth and efficiency, DIP Program resources are directed to projects that serve the objectives of international defence development and production sharing arrangements and, in addition, to projects that support industry sector strategic objectives and maximize the potential economic return on the resources employed.
>
> "Defence Industry", for the purpose of the Program, is defined as those companies or elements thereof which have or which clearly demonstrate the intent to develop a defence-oriented capability or capacity employing advanced management, engineering and technology directed to defence export sales and related civil export sales which arise from that capability or capacity.
>
> The eligibility criteria specify that:
>
> (a) The company proposing the project must be established in Canada and must substantially undertake the project in Canada.
>
> (b) The project must be compatible with the structure, resources and future potential of the company and its approved corporate strategy.
>
> (c) The project must be directly related to defence export markets and/or related civil export markets which employ technology important to Canada's national defence.
>
> (d) *There must be attractive market opportunities in defence export markets and related civil export markets for the resultant product and reasonable prospects that the company can successfully market the resultant product. To determine the adequacy of the potential market, minimum ratios of expected sales to Program support are expected to be adhered to although other factors will also be taken into consideration.* Examples are Canadian defence requirements, industrial development goals and objectives, incremental profits available to firms, etc.
>
> *Where an immediate market is apparent, the applicable ratio of sales to Program support should be 10 to 20 times of [sic] the Crown investment. The Canadian content of the expected product sales is the determining factor in the application of this ratio. Where the Canadian content is less than 50 per cent, the ratio should approach 20 to 1: where the Canadian content is greater than 50 per cent the ratio may approach 10 to 1.*
>
> Where the market is in the future, projects should be evaluated by means of a technological forecast of the demand for the product coupled wherever possible with documented evidence of the market. In this connection it is important to establish that access to the export market will be possible when the product is ready for sale.
>
> (e) *The project must demonstrate the potential for generating an acceptable incremental return on the investment required to be made by the company and Government.* This return would normally take into account such factors as incremental export sales, import replacement, employment, profit, capacity utilization, etc. [Emphasis added.]

The foregoing overall objective and criteria embrace a number of objectives, and the first questions to consider concern their ranking and mutual consistency. It is clear that DIPP's main emphasis is intended to be on exports, but the technology involved is also explicitly required to be important to Canada's national defence. Supported projects must also promote the Department's industry-sector strategic objectives, and they must maximize the potential economic return on the resources employed. These requirements obviously are not necessarily consistent with one another. It is also apparent that the requirement of maximization of the return to the combined outlays of the recipient firm and the government is highly likely to conflict with the implicit goal of any subsidy program – namely, to foster desirable activity that would not otherwise take place. Finally, it is apparent that to rely upon sales ratios to determine eligibility for subsidies is to rely upon criteria that are potentially ambiguous, to say the least.

Types and Amounts of Assistance Provided under the Program

The following categories of assistance available under DIPP have, by and large, been available throughout most of its existence. The first three categories are the important ones, especially the first. It alone accounts for well over half the value of the subsidies awarded to date (although its proportion of

the total number of projects supported under the Program is much smaller).

Development assistance

Contributions may be provided to share acceptable costs related to applied research and development activities for defence and defence-related products.

Capital assistance

Contributions and loans may be provided to support modernization projects to acquire advanced capital equipment intended to upgrade manufacturing capability for defence and defence-related products. Examples of acceptable types of equipment are:

(a) advanced machine tools, other machines and equipment which increase production rates, lower costs and/or increase quality levels;

(b) test and quality assurance equipment necessary for production of items to quality levels demanded by new defence technology; and

(c) data handling equipment for mechanization of inventory and production control functions, data collection, data analysis and engineering design computation.

Source establishment assistance

Contributions may be provided to share acceptable costs associated with the establishment of a Canadian company as a qualified supplier of defence or defence-related products . . . .

Non-recoverable costs support

Contributions to share acceptable recoverable [sic] and non-recurring costs related to a request for a development or production project by a foreign government may be provided when it can be substantiated that the assistance will offset adverse cost conditions unique to the Canadian suppliers, or to offset costs which foreign competitors have already amortized, or to offset foreign government support to competing firms.

Amounts of assistance provided

For Development, Source Establishment and Non-Recoverable Costs Support (NRCS) projects, the Department normally provides contributions of 50 per cent of the cost. Contributions in excess of 50 per cent may be provided when there are special circumstances or unusual risks to justify an increased contribution. For Capital Assistance projects, the Program finances the full acquisition cost of the equipment on the basis of a 50 per cent loan and 50 per cent contribution. The loan is interest free and title to the equipment remains with the Government until the loan is repaid. In general, it is expected that the company will invest in its modernization program an amount equal to the cost of the capital equipment supported under the Program. This investment by the company may include both capital and non-capital expenditures but should be additional investment to the on-going capital replacement requirements of the company. [See IT&C (1977), pp. 4-5.]

Repayment Requirements with Respect to Contributions

Like certain other federal subsidy programs, DIPP apparently has always had rules providing for the repayment, under specified circumstances, of part of the subsidies received by firms. For example,

> The recovery of the Crown's contribution for Development, Source Establishment and NRCS projects is based on the amount of profit from sales arising from the project supported. The terms of the repayment vary depending upon the size of the company's overall contribution.
>
> In normal circumstances, the employment of funds from the Program will be limited to those companies which are prepared to make a contribution in support of the project equal to or exceeding that of the Crown. In such cases, there will be no recovery of the Crown contribution *except where the profit realized on the initially supported project and/or follow-on production orders is beyond that considered fair and reasonable.*
>
> An allied government contribution of funds may be considered as a company contribution in the assessment of the financial sharing ratio.
>
> In cases where the contractor is not able to make a 50 per cent contribution and a Crown contribution in excess of 50 per cent is provided, the contract entered into with the company will contain a condition that repayment will be made to the Crown as follows:
>
> (a) 25 per cent of all profits up to 10 per cent realized from the initially supported project and/or follow-on production until an equal contribution to the project has been made by the company and the Crown. (In determining when equalization shall be reached, repayments made by the company to the Crown shall be deemed to reduce the contribution of the Crown and increase the contribution of the company by that amount); and
>
> (b) all profit in excess of 10 per cent until the total Crown contribution to the project has been refunded.
>
> *As an alternative to making the required repayments to the Crown, the company may invest all or part of the obligation in special projects.* These projects are to be identified by the Department in advance and included in the Treasury Board Submission. [Emphasis added.]
>
> The projects are to be in the fields of Product Development and/or Source Establishment and/or NRCS for a defence item for production sharing purposes or a related civil export item. [See IT&C (1977), Appendix J, p. 1].

These repayment requirements obviously reflect a desire on the part of the government that its subsidies not result in the earning of excess profits by recipient firms. It matters less for our purposes that the stipulated 10 per cent rate may not be quite optimal (although it probably would be close to it, on average, if conceived in real, pre-tax terms and if it referred to the rate of return on capital rather than on

sales) than that the government has seen fit to impose this rule, at least in principle. It is difficult, however, to say much more than that, in spite of the fact that those provisions have apparently existed for some two decades. It might be thought that such an interval would suffice to permit a judgment as to their significance to the Program, but that, apparently, is not the case.

The above-mentioned, recent independent evaluation of the Program (upon which we shall draw extensively below) included a look at how these repayment provisions have been enforced. Its findings tell a rather curious story. To begin with, there is the fact that, by 1980, repayments totalling a mere $13 million had been collected against Program expenditures on completed projects of $444 million and this total outlay apparently does not include projects that failed or were terminated). It was estimated that some 350 relevant project files are currently in the hands of the Financial Services Branch of the Department of Industry, Trade and Commerce. This is the Branch whose responsibilities include enforcing the repayment provisions of subsidized projects. It is especially striking that, of the $13 million recovered, over 80 per cent ($10.6 million) came from two firms.

What does a repayment record of such negligible proportions (that excludes all but a small handful of subsidized firms) mean in terms of the efficiency and effectiveness of the Program? If there were grounds for believing that that aspect of the Program's administrative system concerned with the application of the repayment provisions has been sound, it would imply that, subject to one qualification, firms rarely earned excess profits on subsidized projects. That, in turn, could mean only one of two things. It could mean that most subsidized projects were successful in that they resulted in marketable products but that those products earned only normal profits for their firms; or it could mean that most subsidized projects were either technical or commercial failures. Either of those alternatives would have enormous, though very different, significance for the ongoing *modus operandi* of the Program. But, unfortunately, there is no way of knowing which of these situations actually obtained. It appears that the foregoing necessary condition – namely, that the repayment provisions be administered soundly – cannot be said to have been met.

The Financial Services Branch sends letters annually to recipient firms requesting relevant sales information. From those sales data, profit levels are then supposed to be computed and, where warranted, invoices for the amounts to be repaid sent. It has been found, however, that the reality is quite different. Some recipient firms report regularly; others report occasionally and others do not report at all. It appears that there is little follow-up on the part of the Branch.

There remains the qualification that recipient firms may re-invest excess profits from subsidized projects in appropriate new projects in lieu of making repayments to the Crown. No data could be found pertaining to such reinvestment activity, because, apparently, no such data have systematically been gathered anywhere in the Program's administrative machinery.

It appears, then, that the question asked above with respect to the meaning of the negligible repayments made by recipient firms must be regarded as open.

The Program's Current Delivery System

Projects involving any of the three basic types of assistance offered by DIPP could always, in principle, be initiated in one of the following ways:

a) a firm conceives a project on its own and presents it to the Program;

b) an official of the Department has an idea and asks a firm to formulate a project; or

c) a project emerges as a joint effort with another government, the idea originating with one or the other.

In practice, about 70 per cent of all R&D projects have originated with firms, the remainder being divided equally between the other two sources. Almost all capital assistance and source establishment projects have been initiated by firms.

The Department's industry-sector branches play a very important role in the processing of a project proposal once it has been initiated. Officials from the relevant branch gather together the various elements that eventually make up the Project Submission, which goes to the group that makes the ultimate decision whether or not to support the project. With inputs from a variety of other departmental units, the group assesses the technological features of the project, the market potential of the resulting product, and the project's financial implications both to the firm and to the Program. With respect to market potential, the requisite sales ratios quoted above are applied, and special emphasis is placed on exports. Risk factors are also evaluated. As for the financial implications, the sort of corporate approach adopted under EDP is followed. In other words, the overall soundness of the firm is evaluated, and this provides the context within which the project in question is considered as an economic proposition.

When completed, the Project Submission goes to the DIP Committee, which is the body primarily

Sales:	Total	19--	19--	19--	19--	19--	19--	19--	19--
	Domestic								
	Export								
Less:	Cost of sales								
	Material								
	Domestic								
	Import								
	Direct labour								
	Other direct costs								
	Overhead								
	Total cost of sales								
	Profit before taxes								
	Number of units sold								
	Man years employed:								
	Salaried								
	Hourly								

responsible for advising the Deputy Minister of Industry, Trade and Commerce whether a given project should be supported under DIPP. Unlike the analogous EDP body, whose membership is divided equally between private members and officials, the DIP Committee is composed entirely of officials. In addition to the Department of Industry, Trade and Commerce, two other departments are represented – the Department of National Defence, and the Department of Supply and Services. The Committee also has access to a variety of advisory expertise possessed by these departments.

The Program's Current Information System

In addition to the Project Submission, a Corporate Submission is also prepared. This more general document is intended to "form the corporate context within which individual project applications will be considered." It provides for the gathering of quite voluminous information about the applicant firm, its history, ownership, past product and financial track record, competitive environment, management resources, and the like. The firm's prospects over the next several years are also reviewed, along with projections of its financial statements over that period.

As for the Project Submission, it is not improbable that it is the progenitor of the analogous document used by EDP, which also contains quite a few elements of the Corporate Submission. The stipulated format places particular emphasis on the projections of both the firm's total operations and those attributable to the project for which support is being sought.

Projections

In order to illustrate the incremental impact of the proposed project, the projected income statement for the company both with and without the project should be provided. The income statement projections should be based upon the projected income statements in the Corporate Submission (including updates) and follow the same format. Projections with and without the project should normally be for sufficient numbers of years to reflect the project and 3 to 5 years of production. As the Corporate Submission normally includes projections for only 5 years, annual projections beyond 5 years should be extrapolated from year 5.

An incremental income statement should also be provided for the project based on the above format for the same number of years.

Accounting treatment of DIP contributions should be identified and should be similar to the accounting treatment employed in the Corporate Submission. Sales projections should be realistic and should be consistent with the discussion of market prospects in the next section. The company's assumptions as to treatment of inflation in the projections must be provided.

Appraisal of Projections

The Branch's appraisal of the company's incremental projections should be provided indicating how reasonable and attainable they are. This will be based upon an analysis of the risk of the research and development project (for Development projects) and an analysis of the sales and cost projections resulting from the DIP assistance project. This appraisal should include references to the Branch's previous appraisal of the company's projections in the Corporate Submission and any subsequent updates. Where a project has been supported, a request for further funding should identify the original sales forecasts and the revised sales forecasts.

The projected sales and market potential for the end product(s) should be examined including the rationale behind the firm's market studies. For major contracts, details of progress to finalize contractual arrangements should be provided. Significant competitive features should be identified within the context of the market environment and the major competitors of the company. The Branch's appraisal of the company's

analysis of market prospects and the marketing strategy are to be provided along with opinions or comments of the DIP Committee. [See IT&C (1977), Appendix C, pp. 3-4.]

The foregoing is, in principle, a very complete description of much, though not all, of the information necessary for a proper economic analysis of the proposed project from the standpoint of a subsidy program. One would have preferred that the project's projected profits be discounted at a specified rate and expressed in terms of a rate of return on investment (capital). Also, explicit reference to the existence of inappropriable benefits from the project might have been required – assuming that McFetridge's "on average" notion is tenable – but it would be best if the necessary estimates were prepared jointly by the applicant and program administrators.

Although this information system is, as indicated, capable of being adapted without undue difficulty to permit the kind of economic analysis needed for proper judgments about the probable incrementality of projects, the fact remains that it was not created with that end in view. In other words, the system was not designed to isolate those specific projects which, if proceeded with, would serve the interests of Canada but whose private returns would be below private costs, thus necessitating subsidization. Rather, it was designed to assure those who judged the applications that the proposed project would, above all, be profitable to the applicant firm, though not unduly so (hence the repayment provisions). As used in the above format, the term "incremental" has an entirely different sense from that in which it is used throughout this study; it is used in the format to refer to the positive contributions that a project is required to make to a firm's export sales and profits. While it would be excessive to suggest that using the term in this sense tells us nothing about whether the firm would proceed with the project without government support, there is no doubt that the light shed by this usage upon the firm's probable behaviour is very murky.

Earlier Delivery and Information Systems

The overwhelming proportion of the projects supported under DIPP – and all the projects discussed collectively below – originated prior to 1977. It is therefore essential to consider the nature of the delivery system of the Program and, particularly, the informational basis of decisions as they existed during those preceding years.

The composition of the group that made the recommendation to Treasury Board to extend support to a given project varied over the period. That reflected the different departmental structures that then existed, which eventually evolved into the Department of Industry, Trade and Commerce. Advisory groups, composed of officials from various government bodies having relevant, specialized interests in defence production, provided technical advice of various kinds. In essence, as opposed to form, however, the Program's delivery system during the earlier period seems to have been essentially similar to its later version.

Decidedly, the same cannot be said of the information system upon which decisions were based. If the post-1977 system is formally specified in great detail, the opposite is true of the system(s) that existed earlier. The decision makers were admittedly required to satisfy themselves that projects met the Program's various eligibility requirements, including the requisite sales ratios, but they were obliged to obtain very little in the way of detailed information from applicant firms. Consider the following extracts from a 1973 administrative directive:

> When reviewing Development project assistance the Branch concerned shall consider:
>
> (a) the size of the potential military market and the extent of production sharing potential...
>
> (e) the extent of Canadian military interest...
>
> (g) the size of the potential commercial (civil) market...
>
> (i) the long range economic benefits to Canada in terms of technological advancement, improved balance of payments and compatibility with Canadian industrial growth. [See IT&C (1973), pp. 3-4.]

The most striking feature of this information system is its extreme brevity. The second most striking feature is the fact that a firm's performance is to be measured in terms of sales rather than in terms of profits. Clearly, the information specified would be incapable of enabling program administrators to decide whether a project's attainment of the benefits described in (i) would depend upon DIPP assistance or whether the project would be likely to go ahead without that assistance. Even if the former possibility could somehow be assumed plausibly, there would still be no way of determining whether the incremental benefits would be sufficient to justify the amount of assistance contemplated.

DIPP's Performance

Although comprehensive statistics covering the whole of the Program's lifetime to date are difficult to come by, information provided by its administrators indicates that a large proportion of the subsidies (half or more) has been paid to fewer than a dozen firms.[4] The cases discussed collectively below involve a majority of those firms, which together have received well over $200 million since 1959. It is difficult to

specify the number of projects that were thereby subsidized, not only because many of the projects were clearly interrelated but also because in more than one case, involving numerous projects, it could be surmised that the firm, rather than specific projects, was the intended beneficiary of DIPP support. In any event, and subject to this reservation, the projects commented upon tended to be large ones.

Unlike the EDP projects discussed earlier, these projects have all just about run their courses; and their outcomes are quite fully known. This knowledge is of course useful, but it must be used judiciously, given our purposes. We must, in other words, take care to avoid allowing the outcomes of projects to cast undue glows or shadows retrospectively upon what went before. This said, the fact of the matter is that a large proportion of the projects were probably failures – a fact that must be reckoned with.

We now pause to consider what is meant by a project's success or failure from DIPP's standpoint, apart from those projects that never resulted in sales revenues or that were aborted before completion. There is a major problem here. We could not apply the inappropriable-benefit concept, not only because of the problem of the for-export innovation but also because of a total dearth of relevant data. So we relied upon weaker criteria, revolving around the net returns earned by the firms from the subsidized projects. Although, strictly speaking, this does not necessarily follow, projects that brought negative net returns to their firms were regarded as failures from the Program's standpoint also. Projects that were profitable to their firms are more ambiguous: much depends upon how profitable they were. If they brought only the returns that the firms usually earned on their overall operations, it might be inferred that the subsidy was probably both needed and well calculated. If their returns were either higher or lower than usual, the appropriate inference might be that the subsidies were probably either excessive or insufficient. The actual data situation, however, was so problematic that even these rather tenuous inferences could rarely be drawn with any confidence. Instead, intuitive judgments were made, the overall tendency being to regard projects that seemed reasonably profitable to their firms as probable successes from the standpoint of DIPP.

Granted that each project's outcome deserves to be evaluated in its own terms and granted, as was just implied, that outcome and the quality of decision making can, in any given case, be quite independent of each other, the above-mentioned high rate of failure is surely noteworthy. Bluntly put, it strains credulity to imagine that each and every individual failure was due to unique factors and that there are no general conclusions to be drawn from the overall track record.

One common element in this track record probably relates to the fact that defence production projects are subject to a special element of risk. That is the risk inherent in any innovative project that is tailored to the specific needs of a very few customers – often only one customer. This is not so much a technical risk in the usual sense (that the project may fail to result in the intended product); rather, it is the risk that by the time the project bears fruit, the customers' needs will have changed, for one reason or another. Nor is this risk entirely offset by the possibility that the customers in question, being governments or government-supported, may be less tough with respect to price than would ordinary profit-maximizing firms. A change in the needs of the intended foreign customer(s), occurring late in the day, spelled failure for at least two large projects reviewed. One would expect that the subsidized Canadian firm, to say nothing of DIPP administrators, would have insisted that the foreign customer go beyond the mere expression of interest and put up a significant part of the project's funds before the project was undertaken. That was in fact done in one of the cases; yet, while it was certainly a reasonable and prudent stipulation from every standpoint, it did not prevent ultimate failure. To at least some degree, this contingency seems to be a noninsurable risk.

Factors Contributing to DIPP's Performance

The most likely, general explanation for the high incidence of nonsuccess is the failure on the part of DIPP's administrators to ask the right questions (and to insist upon plausible answers). They also tended to violate their own criteria. For example, one of the eligibility criteria cited above specifies that subsidized projects must demonstrate the potentiality for generating an "acceptable" return to the innovative firm. It is evident from an examination of the files of various large projects (to which, it might be expected, the rules were most scrupulously applied) and also from discussions with program administrators, that this criterion often was honoured in the breach. What tended to be estimated was future sales – sometimes only in terms of physical units. These, in turn, tended to be expressed in aggregate terms rather than in per-year terms. Future production costs were usually not estimated, in either aggregate or per-year terms; hence future returns were really not taken into account.

A factor that may have contributed to the *extent* of the losses from unsuccessful projects, even if it did not greatly affect the rate of failure, is the dilemma of

when to call a halt. As is done under other subsidy programs, DIPP payments are usually paid in instalments, reflecting the progress of the project. Consequently, administrators are faced with a series of decisions (following the initial decision to subsidize the project), once the original bright prospects start losing their glow, as to whether to maintain the financial injections or to stop and cut losses. There were at least a few cases where administrators allowed hope to triumph over experience; and consequently the Program (to say nothing of the firms) lost more money in the end than it needed to have lost. The officials involved in the various successive decisions tended not to be the same throughout; so this could, in some cases, have had some bearing upon their approach to the issue of whether to continue DIPP support in the face of discouraging events or prospects. A given administrator facing a decision about a given instalment, knowing that he had no part in any of the previous decisions and that he would be unlikely to have a part in subsequent ones, might be inclined to contemplate the situation differently from an administrator who was involved before and expected to be involved again, or who expected to be answerable for the project's ultimate outcome. This consideration is independent of the burden of knowing that a decision to call a halt before paying the next instalment, which might be relatively small in itself, would in effect be a decision to write off the possibly large aggregate of all previous payments. It is therefore understandable that a discretion that is costly to the taxpayer can quite rationally and uncynically become the better part of bureaucratic valour. This is especially true when, as is often the case, the project's current prospects, though less bright than before, are not entirely hopeless. Nor is it impossible that such circumstances may have contributed to a less stringent approach to projects when they were first proposed (and thus to a higher failure rate), since those who gave the initial green light could be fairly confident that they would be long gone by the time the projects' returns were discernible. If the returns should prove to be negative, their roles would be, if not forgotten, at least obscured by those of all their various successors who, each in his own turn, had approved the subsequent instalment payments. Like the element of noninsurable risk that arises from dependence upon oligopsonistic purchasers, this potentially perverse administrative incentive seems to be an inherent one. It appears to inhere in the nature of undertakings by large organizations that come to fruition only after long intervals. Hence it can only be offset (partly or wholly), rather than eradicated, by countervailing mechanisms. Their function would be to monitor independently the progress and current prospects of subsidized projects. As will be seen shortly, monitoring constitutes another area where DIPP's performance to date leaves much to be desired.

Multinational Enterprises

One large project that was reviewed specifically and that does not seem to have turned out very satisfactorily from DIPP's standpoint requires some discussion, because the issues it presented to the Program's administrators are not unusual, given the structure of Canada's defence production industry. The firm in question is a subsidiary of a U.S. multinational enterprise, which has analogous production capabilities in both Canada and the United States (and perhaps elsewhere as well). The objective of the administrators was to induce the multinational parent to assign the project to its Canadian subsidiary.

As far as one can tell from the documents, program administrators never systematically addressed the following critical question: What is the minimum subsidy required to accomplish this objective? They apparently never put the question explicitly to themselves; or if they did, they certainly did not go about answering it in a coherent fashion, since the information necessary to provide the answer was not gathered.

What, in a nutshell, the program administrators would need to know before offering a subsidy in a situation like this is the minimum that would be required to move the multinational enterprise away from the margin of indifference between its various international facilities and towards its Canadian facilities. It is generally the case that the demand for a project's ultimate product is independent of the scene of production; hence the same volume of production could be anticipated, whatever its geographic origin. Once the question is properly put, the task becomes one of specifying the informational components of a correct answer in the existing circumstances. For example, if the proposed project envisages a product that ultimately will be sold to third parties, the administrators will need to estimate the unsubsidized rate of return that the Canadian facilities could realistically expect to earn from the project, as well as that which the multinational enterprise's most efficient foreign facilities could expect to earn from it. A subsidy that would enable the Canadian facilities to expect a rate of return slightly higher than that which the alternative facilities could expect should suffice to cover the opportunity cost of Canadian production and thus bring the project to Canada. (The underlying assumption here is that, prior to the advent of the project, the multinational firm had allocated its overall activities among its various subsidiaries so as to equate their marginal rates of return. By doing this, it would have maxi-

mized its total profits.) Another example drawn from DIPP experience concerns a project whose prospective product was an intermediate good that formed part of the multinational enterprise's final product. The question was whether the intermediate good would be developed and produced by its Canadian or by its U.S. facilities, the latter allegedly being more efficient than the former. There is evidence to suggest that program administrators did not carefully ascertain, as they should have done before awarding the subsidy, the magnitude of the cost disadvantage faced by the Canadian subsidiary.

It thus seems clear that program administrators did not always put the central issue in its proper terms when dealing with multinational enterprises that had the choice of whether to proceed with their projects in Canada or elsewhere. And when they did not put the issue properly, the information they gathered tended to be incapable of yielding appropriate answers. There is consequently reason to doubt (to put it no stronger) whether all of the subsidies paid to multinational enterprises were well calculated or whether they were always necessary.

Competing Subsidies

A related issue that program administrators have had to address regularly over the years is that of competing subsidies – subsidies paid by the governments of other countries to their domestic defence production industries so as to render them more competitive in international markets. This type of subsidy, which can take a variety of forms, is quite common in the world. Here, too, the main challenge to the DIPP administrator is to put the proper questions and to generate the information needed to answer them correctly. It appears that his main emphasis hitherto has been on estimating and expressing as a proportion of project cost the subsidies paid by foreign governments to their domestic producers in support of given projects – and then matching them. Although the strong possibility, developed earlier, that the subsidization by foreign governments of for-export innovations may serve to benefit importers, including Canadians, at the expense of domestic taxpayers seems not to have been recognized by the DIPP administration, this is not the only reason for regarding this "matching" approach as inadequate. Granted that it has the merit of placing the Canadian innovator on the same competitive basis as his foreign counterparts, it nevertheless tends to obscure the main issues. The important questions here, as elsewhere, are: Is a subsidy needed and is it warranted? If so, how much should it be? In the event (probably fairly rare, in the nature of things) that it is deemed to be in the national interest for a specific for-export project to be undertaken in Canada, irrespective of the inappropriable benefits bestowed upon foreigners, then the first step must be to estimate the probable lowest price required by a foreign competitor for the project's ultimate product. Then the issue is whether the Canadian firm will be able, on its own, to meet that price and still earn a normal profit. Only if it cannot do so does the question of a subsidy arise, and it arises only to the extent that it will enable the Canadian firm to meet the competition while covering its opportunity cost. It is apparent that for DIPP administrators to disregard these considerations and seek merely to neutralize competing subsidies as an end in itself is to court misallocations of their resources.

Project Monitoring and Program Evaluation

One of the most striking impressions that emerges from a perusal of various DIPP files and other documents, and from discussions with administrators, is of the relative lack of attention that has hitherto been devoted to monitoring the progress and appraising the outcomes of subsidized projects. This state of affairs has apparently extended over most of the Program's lifetime, possibly because of inadequate resources, in spite of the fact that there has always existed various formal requirements for the monitoring and appraising of supported projects. Not only have these requirements tended to be neglected but, as was reported earlier, so also has the one regarding the repayment of subsidies by firms when they earn "excessive" profits from subsidized projects. (As an alternative to repayment, firms were given the option of investing in approved projects.) There is evidence that the efforts made to gather the information on subsidized projects that was needed to apply these rules tended to be less than strenuous. If it is impossible to assert categorically, in retrospect, that a proper monitoring and appraisal system would have resulted in a measurably higher success rate for the Program as a whole, it is certainly reasonable to suggest that it probably would have done so. The way in which the Program was actually administered precluded the early recognition of problems, the taking of remedial action in good time, or the learning from past experience of valuable, if expensive, lessons for the future.

Two Evaluative Misconceptions

The Program, however, was formally reviewed, as a whole, on several occasions over the years, and there was at least one occasion when the large subsidies (both in terms of projects and amounts) paid to an individual firm were subjected collectively to a formal

benefit/cost analysis. It has been possible to examine the terms of reference and the reports of only some of these exercises, so one cannot generalize about them. What is known, however, is that most of them apparently produced few recommendations for change in either the Program's mandate or in its *modus operandi*. In any event, few changes occurred. One possible exception is the most recent, and perhaps the most exhaustive, of these reviews (the one mentioned earlier), which was performed by an outside consultant and completed in 1980. Because there are indications that some of the questionable thinking reflected in these review exercises is, or was, shared by senior DIPP administrators, a few comments upon that thinking are in order.

The notion seems to be widespread that even if the subsidized projects often failed, the subsidies at least served to keep the firms in question going during lean times, and they preserved intact teams of highly skilled professionals that would otherwise probably have dissolved. Moreover, useful lessons were learned from the failures. There is a certain validity in this type of reasoning, especially with regard to the preservation of professional teams, but it should not be exaggerated. Resources, particularly highly skilled human resources, have multiple uses. It is almost never the case that if they were not devoted to a specific, narrowly defined end, they would otherwise remain idle. In other words, just about every economic undertaking has its own opportunity cost – the value of its best forgone alternative – a cost that must be reckoned with in rational calculations. Failure to recognize this fact can easily contribute to a tendency to view untoward events complacently and not draw necessary, if unpleasant, conclusions. As for the notion that there are useful lessons to be learned from failure, that is a truism that deserves the shortest possible shrift. Of all possible teachers, failure is surely the most costly and ambiguous.

There has also existed a pronounced tendency to count among their benefits, in one way or another, the employment consequences of subsidized projects. Now, counting jobs created as one of a subsidized project's benefits is, in principle, unobjectionable (assuming, of course, that the sums are done correctly), provided that two conditions are met. The first condition (the familiar one) is that of the project's incrementality to both the firm and the industry. It hardly needs reiterating at this stage that a subsidized project that would have proceeded without subsidization or that pre-empts or displaces an equivalent project by another firm in the industry brings neither new jobs nor any other desiderata to the economy. While it may well be true, as is suggested below, that a respectable proportion of DIPP-supported projects were in fact incremental in both these respects, that can be no more than an intuitive impression, since the Program's rules have never required the application of any explicit incrementality criteria; nor, apparently, have its administrators ever informally applied any. The second condition derives from the fact that subsidies and the very substantial costs involved in financing and delivering them all represent resources that would, if they had been otherwise deployed (as they undoubtedly would have been) have created jobs elsewhere in the economy. If, therefore, the jobs created by (incremental) subsidized projects are to be included among their benefits, then the jobs destroyed by the subsidies and their associated costs must be numbered among their costs. This basic fact does not seem to have been recognized in those reviews of the Program which were available for perusal.

Concluding Remarks

As was just indicated, it may not be unrealistic to assume that even if proper incrementality criteria had been applied, a high proportion of DIPP projects would have met them. There are indications that many projects were subject to high risk factors, so it may well be true that their risk-adjusted net private returns would, if calculated, have proven to be negative. As for incrementality to the industry, given the very high concentration ratios of most defence production industries and the high degree of rival watching that probably takes place, it does not seem likely that many subsidized projects actually displaced or pre-empted equivalent projects of other firms.

But none of this implies that the amounts of the subsidies awarded, however incremental the projects may have been, were well calculated so as to be just sufficient to enable the projects to proceed. Nor, of course, does it imply that subsidized projects were generally expected to be in Canada's interests, in terms comparable to those defined in previous chapters. This remains true even if we assume, as McFetridge suggests we should, that a for-export project's inappropriable benefits tend, on average, to redound, via imports, to domestic consumers. Since the very notion that such benefits exist and need somehow to be reckoned with has apparently never entered the mind of anyone administering the Program, there is no basis for any such implication. In other words, even the suspension of disbelief that a project's inappropriable benefits to foreigners serve as an adequate indicator of its domestic inappropriable benefits fails to impart merit to the fashion in which DIPP was operated during its first two decades. The basic problem, once again, is not that the right questions were answered incorrectly; it is that they were never asked.

Consider, in addition to the above examples, the cases where individual firms received numerous specific subsidies, with every (or almost every) subsidy being paid without much analysis of the project's economic prospects. It is fair to assume that the Program's real, if implicit, objective in these cases may have been to keep the firms in their present lines of business. That, of course, would have been a perfectly reasonable objective, as was argued above, but pursuing it properly would have required posing and answering the appropriate questions. These questions involved the firms' opportunity-cost rates of return, their prospective unsubsidized rates of return, and the like. Apparently, no such considerations were ever explored.

The fundamental reason why the most important questions were generally not raised is probably that DIPP's administration was never explicitly enjoined, in the Program's terms of reference or in its administrative directives (as, for example, EDP's administration had been enjoined), to restrict its support to desirable activities that would not otherwise occur. That prevented the evolution of a decision-making machinery, animated by a clear and coherent sense of its mandate and endowed with the administrative instruments appropriate to the fulfilment of that mandate. Consider, for example, the Program's eligibility criteria, cited above. As was suggested there, allowing the decision to hinge on "attractive market opportunities" for the proposed project's product and then laying down sales/support ratios conditioned by "Canadian content" could only divert attention from the real questions: Does the project need and deserve a subsidy? If so, to what extent? It is not surprising, therefore, that the various information systems that served the Program's decision making over the past two decades tended to be fragmentary, cursory, and/or ill-focused. Substantial improvement in these systems has taken place in recent years, but the underlying rationale for subsidies has remained inappropriately formulated in operational terms. Had that not been the case, Program administrators might have been forced to shift their focus from the project to the firm because of the practical difficulties in assessing the domestic inappropriable benefits attributable to individual export-oriented projects. Hence, as long as this basic deficiency remains unrectified, the Program is unlikely to serve its legitimate and important purposes in the most efficient manner.

A final word. The analysis presented in Part 1 suggests that a subsidy program catering primarily to for-export innovations will probably prove disadvantageous to Canadians, not only in the relative sense that it will probably benefit foreigners more than Canadians but, more seriously, in the absolute sense that it will probably leave Canadians worse off than they were before the subsidies were paid. The saving grace of a program such as DIPP resides in its emphasis upon defence production, which gives it an inherent *raison d'être* that is independent of the question of the best focus of the subsidies. It was argued that Canada's interests would be better served if DIPP were to shift its focus from projects to firms, and a few of the implications of such a shift were tentatively explored.

If, however, the view expressed by McFetridge is adopted – namely, that the inappropriable benefits that the for-export innovation bestows upon foreigners may, on average, properly serve as the measure of the inappropriable benefits it will ultimately bestow upon Canadians – then there is much less need to shift the Program's focus. Nor, of course, is there the same need to change its *modus operandi*, as described (if not yet fully implemented) in its most recent administrative rules. As was indicated above, these rules go a long way in the right direction. They will, however, need to be augmented to provide for the calculation of proposed projects' inappropriable benefits. Second, the Program's administrative machinery will need substantial modification to enable it to perform the various retrospective evaluation functions discussed in Chapter 1.

The fact remains, however, that reliance upon an innovation's foreign inappropriable benefits as the measure of its domestic inappropiable benefits is perilous and, in all probability, unprofitable. That places DIPP's traditional project-specific focus squarely in the category of second-best. Since the alternative firm-specific focus advocated above is not only clearly superior on conceptual grounds but also probably easier to administer, there is no reason for the transition from the existing focus to the recommended one not to begin as soon as possible.

4 Three Smaller Subsidy Programs

The three programs discussed in this chapter were all conceived within the context, and are operated under the aegis, of the National Research Council of Canada.

1 The Industrial Research Assistance Program (IRAP)

This Program was established in 1962, at a time when increasing concern was being voiced about the relatively low level of spending in Canada on nondefence R&D. Now that DIPP was under way in the area of defence production, it was felt that something analogous was also needed to promote innovative activity in the rest of the industrial sector. IRAP was the result and, since its inception, it has represented one of the most important mechanisms whereby the National Research Council provides assistance to the private sector.

Program Objective

The objective of IRAP is as follows [see NRC (1981), p. 2]:

> The objective of the program is to increase the calibre and scope of industrial research in Canada *in situations where it leads to high business effectiveness with economic and/or social benefit to Canada.*
>
> This objective will be pursued by providing financial support for approved research workers engaged in approved industrial research projects of high technical merit *showing prospects of a high return and with good business plans for achieving success.* Such projects should:
>
> (a) be aimed at innovative products or processes realistic to the company and of significant need or benefit to the economic and/or social life of Canada, and might particularly
>
> (b) relate to research which, *in relation to the company's resources, is an unusually high risk, expensive, or longer range area, but where the potential benefits nevertheless appear large,* and/or
>
> (c) be designed to increase Canada's competitiveness in world trade in realistic situations by strengthening a necessary technological base in a company's present field or in an appropriate new field, and/or
>
> (d) encourage participation by government and university scientists in industrial activities, and/or
>
> (e) assist the attainment of the objectives of the Canadian Government's industrial strategy as it may be formulated from time to time. [Emphasis added.]

The foregoing statement of the Program's objective makes it quite explicit that IRAP is intended to support projects that promise to result in commercial success. Granted that supported projects should also carry unusually high risk in relation to the firm's resources, be expensive, or be of a long-range nature, these factors should, in effect, be compensated for by the project's potential benefits. Similar emphasis on the ultimate economic benefits of supported projects is to be found in the following statement with respect to the eligibility of firms for IRAP assistance and to the criteria governing project selection [p. 4].

Eligible Firms and Criteria

> ... Companies must possess adequate and sound financial resources and have a demonstrable ability to complete effectively the subsequent development work in Canada and to use or market the products or processes from a Canadian base in the best interests of the company and the Canadian economy.
>
> Companies unable to exploit their research results through Canadian facilities, or with significantly restricted access to realistic export markets in the field of the proposed project, are ineligible.
>
> ... *Selection of projects is based primarily on their likelihood of successfully initiating a significant technological advance of benefit to Canadian industry and society through commercial development and application in Canada.* Suitability of projects will be judged in the light of the applicant's expertise in the relevant field and ability to commercialize effectively the research findings.
>
> *Projects must be scientifically feasible, commercially realistic to the applicant company and have in view marketable end-products or processes for which a demonstrable need, or an opportunity, is foreseen, and for which an accessible market sufficient to justify exploitation in Canada is anticipated.*
>
> Projects must involve applied experimental research in the physical or life sciences requiring the services of qualified scientists or engineers, and be aimed at generating a sufficient background of knowledge to bring a novel concept or invention to a stage *where commercial development, with or without other government incentive programs, is feasible.* Projects may involve exploratory work in engineering to establish design principles for a proposed product or process. Novel computer programming and software research projects, as well as mathematical research

> projects, may be eligible for support if directed to a marketable industrial product or process.
>
> Projects directed to the development of marketable products or hardware in the fields of medical technology, social science, and the humanities in an industrial context may be eligible, but projects comprising geological and geophysical explorations, market research and routine minor product improvement or technical service activities are ineligible.
>
> Projects should be of such a magnitude as to require at least one professional and an assistant for the duration of a period of about two years, full time. Projects which involve the introduction of a permanent research team into a company new to research, or which involve the expansion of existing research staff, are preferred by [the Committee on Industrial Research Assistance]. As an alternative for a company too small to expect to be able to maintain a viable research effort out of its own resources, consideration will be given to projects which the company would contract out elsewhere in Canada. [Emphasis added.]

It is difficult to say, in the abstract, how closely IRAP's objective and criteria conform to the conditions that valid government subsidization of private R&D must meet. These conditions, as developed in this study and elsewhere, are essentially twofold. First, there must exist a present-value, risk-adjusted excess of the project's private costs over its private benefits. This excess represents the maximum subsidy that is valid, subject to the second condition – namely, that there must also exist an equal or greater present-value, risk-adjusted excess of the project's inappropriable benefits over the sum of the subsidy and the costs of delivering it. The prospect of the Program's objective and criteria conforming fairly closely to at least the first condition is, on the face of it, encouraging. The reference in the stated Program objective to projects that combine large potential benefits with unusually high risk, etc., could be understood in these terms. Whether the same is true with respect to our second condition, which turns on inappropriable benefits, is rather less apparent, although the reference to "economic and/or social benefit to Canada" allows us to hope. What matters in the end, of course, is how IRAP actually operates. Here, the important considerations are, for the most part, practical ones. After describing the assistance provided by the Program and its decision-making machinery, we shall examine one of these considerations, the informational basis upon which decisions to award or deny assistance is made.

Type of Assistance Provided under the Program

IRAP's assistance consists of paying the salaries of scientists, engineers, technologists, and technicians in approved positions in approved projects. As a rule, this assistance will total less than half the project's total cost. These projects are in effect required to be relatively long-term in nature, usually lasting two to three years. The subsidies, however, are made on an annual basis, and there is a procedure whereby the project undergoes an annual review. This review forms the basis of the assistance awarded for each successive year. The implications of these arrangements are important and will be discussed below.

The Program's Delivery System

Projects originate with applicant firms. Thereafter, a central role is played by the Committee on Industrial Research Assistance (CIRA). CIRA is composed of representatives of the National Research Council and various other federal departments and agencies having a direct interest in industrial research. It reviews project proposals and makes the final decision as to whether or not to award assistance. As in the case of EDP and DIPP, the vetting process tends to weed out a large proportion of the less likely candidates for support. Hence by the time a proposal reaches CIRA, its chances of being accepted are good.

Each supported project is assigned a scientific liaison officer (an official at one or another federal department or agency) who is competent in the research area covered by the project. This person visits the site where the project is being carried out, at least once annually, to assess its progress and to be able to advise CIRA with respect to supporting the work in the following year.

The Informational Basis of CIRA's Decisions

Applicants for IRAP support are required to complete two sets of forms in addition to the written proposal that they submit in support of their application. One set, consisting of Forms A and B, involves data with respect to the firm. Form A provides for data on sales, total employees, R&D expenditures, and other government support. Three years are covered: the current year, the preceding year, and the forthcoming year. Form B involves mainly nonfinancial information concerning the firm's R&D resources, in physical and human terms. The same three years are covered. The second set consists of three forms. Forms C1 and C2 involve information, covering one year, concerning the personnel involved in the project. Form D involves information, again for one year, concerning other costs of the project.

It is evident – without prejudice to the contents of the firms' proposals, about which something will be said shortly – that the information formally required from applicants is utterly incapable of permitting a

rational judgment as to whether the project warrants subsidization. Even if we disregard the analytically crucial problem of estimating a given project's inappropriable benefits, the above informational requirements tell us nothing, directly or indirectly, about the project's net private benefits – i.e., about its future flows of private costs and revenues. Hence program administrators cannot even begin to consider the most immediate question that they should ask: Is the firm likely to proceed with the project if it is not subsidized? Nor, when the answer to this question proves to be negative, are they in a position to ask the other essential questions: What is the appropriate amount of this necessary subsidy? Is the subsidy worthwhile from the standpoint of Canadian society; i.e., will the project's (domestic) inappropriable benefits exceed the subsidy plus the costs of delivering it? None of the answers to these questions is accessible from the above information. This fundamentally unsatisfactory state of affairs is rendered all the more inadequate by the one-year-at-a-time method of awarding the subsidies to approved projects and of monitoring their progress. Important though proper monitoring is to an efficiently administered subsidy program, this kind of constricted horizon simply precludes sound *a priori* judgment, which, after all, depends upon accurate present-value estimates of the projects' future flows of costs and returns, both private and inappropriable.

A review of the files of several of the larger projects subsidized by IRAP was conducted, during which not only the above-mentioned prescribed forms were perused but also the firms' proposals and the annual reports of the scientific liaison officers. This review amply confirmed the impression that the Program's information system has been inadequate thus far.

Authoritative evidence has recently emerged that sheds light on the attitude that has prevailed at the National Research Council, presumably throughout, with respect to both the prior and retrospective evaluation of projects.

> *Benefits accrue in two ways [see NRC (1980), p. 86]:*
>
> (a) directly, from sales of resultant products and services, cost savings on related products, generation of new continuing employment;
>
> (b) indirectly, by future benefits from the [science and technology] that include increased ability to compete in the marketplace, impact on other companies or even on a major segment of industry if a major innovation were to occur, resulting in increased demand on both the primary and secondary goods sectors.
>
> Benefits are difficult to estimate with accuracy, although direct sales can often be closely correlated with R&D if they occur soon after the research has been completed. *Indirect benefits are much more difficult to determine and it is usually better to obtain an evaluation from the company than it is to perform an independent assessment since the company should be in a position to market the product.* R&D expenditures are not the only costs associated with innovations; in fact the remaining aspects, design, engineering and marketing may cost as much as five times that of R&D. Benefit/cost ratios have to be adjusted for these factors in deriving the overall rates of return. [Emphasis added.]

The foregoing mixture of insight and misconception goes far to explain the wide gap between the promising formulations of the Program's objective and criteria and their inadequate implementation in its *modus operandi*. Although they are not without significance in their own right, the confusion embodied in the above distinction between direct and indirect benefits is less important than other misconceptions. Foremost among these is the emphasis placed upon the sales of resultant products and services, rather than the net returns from those sales, both to the firms and to society at large. Also disturbing is the notion that the applicant firm is better equipped than program administrators to assess the wider economic impact of the prospective innovation (even given the ambiguous formulation of "indirect" benefits). The above-quoted statement is certainly correct in its references to the importance of the non-R&D costs associated with innovations and to the need to take them into account in benefit/cost analyses seeking to derive projects' rates of return. But, unfortunately, this important insight has not yet been translated into administrative mechanisms that would serve the cause of program efficiency and effectiveness.[1]

A Recent Evaluation of IRAP

IRAP was evaluated in a comprehensive assessment by NRC in 1979. Sales resulting from a particular project were accumulated over a period of time equal to the length of the R&D project, starting with the first significant sale. This probably undervalues the full market. The results of the evaluation are as follows with all costs expressed in constant 1976 dollars.

Projects	485
Program costs	$93.5 million
Company costs	$140 million
Sales based on projects	$1,840 million
Sales/IRAP costs, using current dollars,	20:1
Sales/IRAP costs	45:1

The economic activity generated by the sales of $1,840 million can be translated into the creation of 31,000 new jobs, or one job per $3,000 of program funds. Benefits include both direct and indirect results of the IRAP projects. The company investment in production capital equipment is estimated to be $200 million. The companies are considered to require 350 scientists and engineers to maintain the rate of sales

> from the IRAP projects. It is further estimated that a 10:1 ratio of sales/IRAP costs would produce federal taxes equal to the total cost of the program. The greater returns pay for the program several times. [NRC (1980), pp. 86-87.]

The present writer was reliably informed by senior officials of the National Research Council that the foregoing evaluative results were obtained by a procedure that is summarized as follows: A sample of IRAP-supported projects that resulted in sales was gathered for several years during the 1970s. In the case of a great majority of the projects included in the sample, 100 per cent of the associated sales were attributed to the IRAP support received. In other cases, a lesser proportion of the associated sales was attributed to IRAP. These sales data were then related to the associated IRAP funding to produce the sales/IRAP costs ratios cited above. Next, the sales data were applied to the input-output model at Statistics Canada, which was estimated on the basis of 1976 data, and the input requirements presented above were derived.

The first, and most important, point to be made about this evaluation methodology is that it tells us nothing about the incremental impact of IRAP upon the economy or upon any of its components, including those identified above. The reasons for that have been set forth repeatedly in preceding sections of this study and need not be reiterated here. Even if a valid measure of the subsidies' incrementality to recipient firms (to say nothing of the economy) had been developed and utilized, the focus on sales rather than returns would have been inappropriate; and, in any case, the lack of discounting of the revenue flows (gross or net) is a major shortcoming in itself.

The last two sentences in the above quotation are especially piquant, in that they recognize that IRAP subsidies have tax implications, at least in the sense that the economic activity that they generate also produces tax revenues for the government. What is apparently less well recognized is the fact that IRAP subsidies, like all subsidies, are financed by taxes; and there is also no visible awareness that the very process of making the tax-subsidy transfer is itself a very expensive one – a fact that a proper benefit/cost analysis of any subsidy program would have to take into account. To put it another way, even if the above benefits could validly be attributed to IRAP expenditures, they would need to be reduced substantially by the adverse effects of the taxes and other costs that made these expenditures possible.

In discussions related to this research, some senior officials of the National Research Council advanced the argument that much of the R&D activity subsidized by IRAP is of a kind that does not lend itself to the *a priori* application of the incrementality criteria set forth and advocated in this study. They argued, in effect, that many projects involved research that was of so basic a nature that their ultimate benefits, and even many of their later-stage costs, could not realistically be projected until after a good deal of the work had been done and until after a fair amount of time had elapsed. Hence the premature application of any sort of rigorous benefit/cost analysis might well have the effect of conserving subsidy funds at the expense of stifling projects that would, in time, have proven to be eminently worthwhile.

There undoubtedly does exist a "level" of research, of great potential value, that is concerned with problems that are so fundamental and, so to speak, so nebulous that it is very difficult to project their fruits into future flows of revenues and costs. It is also true that such research activity is, in principle, deserving of government financial support, even though the criteria that it would need to meet in order to qualify for that support might well differ markedly for those specified herein. But whether private firms, rather than universities or government laboratories, constitute the most appropriate locale for this type of subsidized research is another question entirely. Neither it nor the preceding question of what criteria are appropriate for the subsidization of such research can seriously be addressed here; but a brief, practical word is in order.

It is obviously dangerous to justify a failure to apply coherent and stringent criteria to the disbursement of government funds on the grounds that the activity in question has a value that, though high, cannot be expressed in monetary terms before the money is handed over. If any such doctrine were to become generally accepted by the government – which, needless to say, has never happened and, happily, is not in prospect – then few requests for subsidization could be rejected on their merits (or lack thereof). This implies that there should exist a pronounced bias on the part of administrators of a subsidy program such as IRAP against projects of that kind, though it need not be a total, uncompromising bias. It is, after all, not impossible that a private firm, rather than an academic or government scientist, could conceive a good idea of this nature that it would be prepared to finance partially. Society would probably be the poorer if this idea fell through for want of some government support. Clearly, a sensible compromise is called for. Most IRAP-supported projects should be required to meet the usual incrementality criteria from the start. That should be the Program's standard operating principle. It could be relaxed in the case of some exceptional projects that involved "pure" rather than "applied" research. This relaxation, however, should be cautious; tentative; and, above all, temporary. IRAP should advance no more money

at the outset than is required to get the project off the ground. The recipient firm should be given a strict time limit (which should err on the side of underestimation) within which to produce plausible projections of the project's future costs and revenues. Only after such projections have been provided should a further subsidy instalment be made. Even if the initial projections were later to be replaced by other, more realistic ones, the very fact that the second instalment was conditional upon them would be bound to have a salutary effect on all concerned. It would serve to promote a disciplined environment in which everyone operated under the principle that government outlays needed to be justified as concretely as possible and as early as possible. Any proposed projects that could not be handled in this fashion, on the grounds that they involved research at too basic a level, should not be considered under IRAP. They would probably be more relevant to the program discussed next.

2 The Program for Industry/Laboratory Projects (PILP)

The Program for Industry/Laboratory Projects is a comparatively new program of the National Research Council; it was inaugurated in 1975 and is best seen as a complement of IRAP [see Glegg (1981)]:

> IRAP and PILP constitute a pair of complementary instruments for placing the nationally unique and (especially by Canadian standards) enormous Government research apparatus at least partially at the disposal of the private sector with the primary aim of contributing to economic development. Such instruments need to be clearly distinguished from other actual or possible instruments which constitute primarily means for simply funding research and other activities in the private sector whether by tax allowances, grants, contributions, procurements, loans, loan guarantees or whatever other type of contractual or legal instruments . . . .
>
> The effectiveness and strength of IRAP and PILP derive from the quality and size of the singular national resource represented by the laboratory system of the Federal Government which is maintained at an annual cost of more than a billion dollars, a sum in excess of that spent on research and development in the entire private sector. Largely as a consequence of this, it is certainly the case that the Federal Government laboratory system constitutes one of the very few elements of government which is fully comparable in function and type of expertise to a vital element in the private sector and which is clearly superior to it in many respects. It follows from this that the Federal Government's laboratory system has a clearly unique role to play in economic development, to the extent that this is relatable to and derivable from technology-rooted issues ranging from the most general to the most specific and detailed.
>
> Indeed, the relatively large size of the Federal Government laboratory apparatus has frequently, in the past, been viewed by some as a national aberration approaching actual dysfunction, although almost all recent serious opinion tends to see the private sector industrial research activity as too small rather than that of the government as too large. Be this as it may, it is clear that the *existing* government research system constitutes a very major and costly national asset which is not likely to change substantially in size and which should be made to develop the absolute maximum of economic expression consistent with carrying out its internal government role. IRAP and PILP are two well-developed complementary instruments for doing precisely this.
>
> *They are complementary in the sense that whereas projects in IRAP originate overwhelmingly with firms in the private sector, those in PILP originate overwhelmingly with scientists and engineers in government laboratories. Thus, from this point of view, IRAP is basically reactive, driven by market pull, responding to the stated needs of the private sector, while PILP is basically proactive, technology push, seeking to draw private sector firms into contact with product (project) opportunities arising in the technological environment of government laboratories* [emphasis added]. This complementarity is translated into a unified whole by virtue of the fact that both IRAP and PILP are managed day-to-day from the office of the Vice-President (Industry) of NRC who is, in addition, the Chairman of the Interdepartmental Committees which constitute the overall management bodies of the two programs. In both cases, however, the only truly *unique* resource which government brings to the transactions which characterize the programs is its enormous and nationally singular competence in the area of scientific and engineering research.

PILP's Criteria and Its Contractual Agreement with Subsidized Firms

PILP proposals will be evaluated using the following criteria. Only the highest ranking proposals will be funded within the PILP budget allotment [NRC (undated reference)]:

- Economic benefit to Canada
- Good potential market
- Qualified company management
- Enhancement of company R&D capability
- Level of company commitment
- Level of NRC involvement in proposal
- Social benefits to Canada
- Level of technical and commercial risk
- Coincidence with national priorities
- Advancement of scientific knowledge
- Contribution to regional development.

PILP contracts are basically cooperative agreements.

The Company agrees to:

. carry out a development program meeting milestones

. maintain good technical control and report to NRC

. maintain good fiscal control and report to NRC

. commit to make best effort to commercialize the results in Canada

. report on results of commercialization program;

and sometimes to:

. contribute financially to the project

. seek a licence for NRC background technology.

NRC agrees to:

. collaborate in the technical project

. contribute up to 100% of project cost exclusive of major capital items

. monitor ongoing progress, both technical and fiscal

. offer a licence to the background and foreground technology;

and sometimes to:

. allow access to NRC facilities for company personnel to carry out aspects of the technical project [NRC (n.d.)].

Like those of the other subsidy programs reviewed in this study, PILP's criteria do not preclude, to put it negatively, the application of proper incrementality criteria (again assuming that subsidized projects are oriented mainly to domestically consumed products). Evidence relating to the way in which the Program has been operated so far, however, indicates that no such criteria usually have been applied. In other words, the prospective benefits of approved projects, either to firms or to society at large, generally have not been estimated systematically. There is reason to hope that this undesirable state of affairs is in the process of changing for the better. In the recent words of the spokesman for the Program (and for IRAP) quoted above:

> ... there is a much keener awareness of the significance of incrementality than was the case a few years ago. This has led to the formulation of a methodology for estimating the incremental impact of most IRAP and PILP projects (on the firm) and its application will begin within a few months [Glegg (1981)].

This, of course, is no more than a promise, so it remains to be seen how it will be fulfilled by specific administrative mechanisms. It is also important to note that the significance of incrementality has only been recognized with respect to the firm. There is no sign that the realization of the importance of benefits that transcend the firm – namely, inappropriable benefits – has taken root. It is hardly necessary to stress at this stage the crucial role that these inappropriable benefits play in the efficient administration of a project-specific subsidy program.

How PILP Sees Its Performance to Date

This relatively recent program (1975) has generated many projects of which a certain, albeit small, percentage have now reached the marketing stage. Nevertheless it is possible to estimate its economic impact on the basis of expected sales. Information was provided by participating companies for the following summary (constant 1976 dollars):

Program costs (to Sept. 1980)	$19 million
Forecast sales	$3,500 million
Probability of success	20%
Discounted expected sales	$700 million
Expected sales/PILP costs	36:1

The sales/PILP costs ratio of 36:1 is of the same order of magnitude as that for IRAP, demonstrating the high rate of return of these programs. Company investment in production capital equipment is estimated to be $80 million. Continuing new R&D employment to maintain the sales rate is estimated at 100 scientists and engineers. [See NRC (1980), pp. 87-88.]

Given the acknowledged absence of incrementality criteria in the Program's *modus operandi* during the interval, suffice it to say that both the performance measures used and the values attributed to them are open to serious question.

A Concluding Word

The notion of making available to private firms the scientific and technical expertise and the facilities developed within the government laboratory system is, in principle, an excellent one. A lack of access to these kinds of resources by firms (especially smaller firms) has been widely recognized as an important barrier to technological advance.[2] Once the caveats identified here are recognized and the appropriate measures have been taken, PILP will be able to make a valuable contribution to economic development in Canada.

3 The Technical Information Service (TIS)

The Technical Information Service was established in 1945. Its objectives have been described as follows [Kirouac (*circa* 1978)]:

> The main objective of the Technical Information Service of the National Research Council is to provide industry in Canada generally, but particularly the small-industry sector, with the most direct access possible to current technology as it applies to the solution of industrial problems, and to assist directly in the use and application of this technology for the betterment of industry.
>
> Its secondary objectives are:
>
> 1. To assist industry to get easy access to laboratories, libraries and any other sources of scientific and technical information located in the Council;

2. To assist industry to become aware and to make effective use of sources of scientific, technical and other information located outside the Council;

3. To provide direct assistance to industry in the application of the scientific and technical information thus available;

4. To help to establish NRC as a valuable source of technical expertise and information in the improvement of Canada's industry situation generally;

5. Finally, tc encourage and assist agencies in the provinces according to their situations and resources to carry out these objectives on behalf of NRC.

The TIS offers four interrelated programs. The Technical Enquiries Program assists firms with specific technical problems; the Industrial Engineering Program focuses on productivity improvement; the Technological Development Program conveys information to firms on developments relevant to their operations; and the Science and Engineering Student Program provides technical and financial support to firms hiring students who are undertaking short-term scientific or technical projects. The facilities of the first three programs are, for the most part, provided free of charge. The Service has 16 field offices across Canada; these are located in such a way that some 80 per cent of their potential users are within 50 miles of an office. Its target clientele is the overwhelming proportion of Canadian manufacturing enterprises that have little or no in-house engineering capabilities and whose management, for one reason or another, is not familiar with the current technological developments and literature that could be relevant for their operations.

It seems reasonable to suggest that the stringent criteria that have been applied to the other subsidy programs be relaxed in relation to TIS. There is a recognized need for smaller firms to avail themselves of the technical expertise and technological information that are available to larger firms. Since the Service seeks to meet this need in a nondiscriminatory manner, there is little inequity in its work that would tend to alter unfairly, at the taxpayer's expense, competitive relations between firms. And given its relatively small cost, its overall impact is probably a positive one.

5 Recapitulation

It is useful to summarize briefly the major implications of the conceptual discussion in Chapter 1. And, although each of the three subsequent, program-specific chapters ends with its own summary or equivalent, it is also useful to pull together several common considerations, as well as repeat one or two distinctive ones.

The first point to be stressed is that project-specific innovation subsidy programs are conceptually valid when the projected product is intended mainly for domestic consumption. Whatever its other merits, the competitive market system is inherently incapable of providing an environment in which the socially optimal volume of R&D spending will take place. Although this incapacity can be ameliorated substantially by an efficient patent system, it cannot be eliminated entirely; hence well-focused and soundly administered subsidy programs are justified. The operative terms, of course, are "well-focused" and "soundly administered." They define the "trade-off," so to speak, that such programs inevitably involve, a bureaucratic price, borne ultimately by society, which is worthwhile but not at all trivial. The subsidy programs must, first, be conceived and administered so as to facilitate the distinguishing of those private projects which *both* need and deserve subsidies from those which do not. Second, the amounts of the subsidies needed and deserved must be sensibly estimated. And, third, the programs' administrations must contain mechanisms capable of indicating whether, taking due account of the fact that such programs are expensive, they are actually generating enough social benefits to more than offset their costs – whether, in fact, they render Canadians better off.

It is demonstrable that once the nature of the nettle is well understood and firmly grasped by program administrators, these conditions are capable of being met satisfactorily, though (again) certainly not effortlessly or costlessly. The crucially important variable – namely, the inappropriable benefits expected to be generated by the project – usually turns out to be estimable from information produced naturally by the determination of the project's expected private benefits (a process that is commonplace nowadays). Another vitally important variable – the total cost of delivering the subsidy – also turns out to be estimable once proper cognizance is taken of its components, especially the marginal deadweight cost of taxation. As for the retrospective evaluation of a program's overall impact, this, too, is manageable once the many questions that need to be answered are clearly formulated and systematically addressed.

Turning to the four subsidy programs reviewed (i.e., disregarding TIS for the reasons given in Chapter 4), the first and most important thing to be said about them is that their collective story to date has been one of failure to ask – let alone answer – the right questions.

Consider first EDP and IRAP. Since, unlike DIPP, their mandates do not explicitly entail a bias in favour of for-export projects, it may be assumed that most of the projects supported by them would be mainly domestically oriented. They may therefore be regarded as being entirely amenable to the rationale and *modus operandi* of an innovation subsidy program developed in Chapter 1. If they have not heretofore been administered in a fashion that is compatible with that rationale – as, indeed, they have not – the fault lies not so much in their mandates but in the ways in which those mandates have been implemented. The implications of this finding are both discouraging and encouraging. Discouraging, because the available evidence does not permit a firm judgment as to the programs' efficacy thus far. (In EDP's case, admittedly, it does afford some grounds for suspecting that its performance has been less than successful, though probably not enormously so. About IRAP, the question must be considered open.) Encouraging, because the changes in their current procedures that are required in order to promise better results are not profound. Indeed, there already exist clear indications that their administrators have learned useful lessons from experience and have begun thinking along more appropriate lines. The distance that these administrators have still to travel should not, therefore, prove to be excessively long, especially if the need to shoulder the burdens of monitoring and retrospective evaluation is genuinely accepted.

It is true that the view prevalent among at least some IRAP administrators – namely, that the projects presented to them for support tend to involve so fundamental a level of scientific inquiry as to render inapplicable, at the time the subsidy decision must be

made, the benefit/cost criteria specified in Chapter 1 – is, in principle, inconsistent with the recommended *weltanschauung*. But once these administrators recognize that an undue readiness on their part to entertain this notion when advanced by applicants is unwarrantedly disarming and likely to inhibit the most efficient deployment of their resources, it will become apparent that a sensible balance must be struck. It seems likely that, upon proper scrutiny, really only a small minority of proposed projects will prove to have so pure a nature as to preclude indefinitely the meaningful projection of their future flows of benefits and costs. Any such projects would probably be more appropriately undertaken by universities than by private firms, or they should be considered for support under PILP rather than under IRAP. A somewhat larger number of proposed projects may warrant a temporary postponement of the application of the requisite criteria in order to enable them to get sufficiently under way to afford a reasonably realistic assessment of their prospects, but these should constitute the exception rather than the rule. In such relatively rare cases, the size of IRAP support should be confined to the minimum, as should the interval during which a proper assessment is deferred. All other projects should be handled from the outset along the lines specified in Chapter 1.

The basic idea underlying PILP is eminently sound. For private firms (especially smaller ones) to be able to join forces with the expertise and facilities embodied within the government laboratory system is to open up hitherto unattainable possibilities – something that is very much in Canada's interests. But, like the projects subsidized under EDP and IRAP, these possibilities are unlikely to be realized adequately unless these collaborative activities are judiciously subjected to both prior and retrospective scrutiny. Happily, here too, there are indications that the thinking of program administrators is evolving along desirable lines.

DIPP, the oldest of the programs reviewed, is, regrettably, also the most problematic, both in terms of its mandate and its modes of operation over the years. It is hardly surprising, therefore, that there is reason to doubt whether Canada has received adequate value for the monies disbursed under its aegis. Nor is it surprising that this program is found to be more in need of reorientation and structural change than any of the others.

It was argued in Chapter 3 that, as a general rule, it is probably a mistake for governments to subsidize exports. Not only is it likely that such subsidies will tend to benefit the foreign consumers of the exported commodities more than the associated imports will benefit domestic consumers, but, more importantly, by the time the dust has settled, the domestic population as a whole is likely to be rendered worse off in absolute terms than it was before. This rule, however, is not without its exceptions, and, fortunately for DIPP's future *raison d'être*, one of them pertains to defence production. Given that a country like Canada must possess a certain domestic defence production capability, it follows that if the continued viability of that capability should require the payment of subsidies, so be it. While this fact may serve to redeem for DIPP a basic *raison d'être*, it offers no support for the continuation of its practice of subsidizing individual projects. A policy of preserving a Canadian defence production capability implies taking measures designed to ensure that certain firms choose to remain in roughly their present areas of endeavour, but it does not necessarily imply that it is in the social interest that specific innovation projects go forward in this country. That is a separate issue altogether, and it is probably true that the ostensible justification for subsidizing any given project in the defence area (broadly defined) usually reduces to a need to preserve intact the productive unit undertaking it – namely, the firm.

It must be emphasized, however, that changing DIPP's focus from the project to the firm is no panacea, not by any means. The task of keeping private firms in desired fields, and at desired scales, with the least strain upon the public purse is a notoriously complex and arduous one under the best of circumstances. The firms' rates of return, subsidized as and when necessary, must suffice to keep them there, but the subsidy regime must also ensure that these guaranteed returns preclude, or at least minimize, laxity and inefficiency on their part. When these desired fields involve national security, the challenge is all the more vexatious. A single chapter in a study basically concerned with quite different questions is hardly the proper place for a full discussion of how such a regime should be installed and maintained; hence only a few basic suggestions were put forward in Chapter 3. Of these, one bears repetition here, because it is uniquely relevant to the defence production field. It concerns the existence, in this field, of a conflict between the public's right to know, its need for economic efficiency, and its own security interests. The problem, briefly put, is this: on the one hand, economic efficiency on the part of subsidized firms is best ensured by exposing their operations to public scrutiny; on the other hand, public scrutiny in the defence production field necessarily precludes the secrecy required by the very public interests that that field exists to serve. Some intermediate instrument is clearly called for, to mediate between these competing desiderata, be it a parliamentary committee or something else.

What is crucial, in this matter, as in so many others considered in this study, is to put the right question and to put it properly. When this is done, a plausible solution to the problem tends to emerge in due course. And although that solution will seldom be easy to implement, neiher is it likely to be impossible. As a general rule, it will lie distinctly within the realm of the workable.

Appendixes

A Risk and Publicly Funded Projects

An important question that program administrators must face concerns the discount rate to be applied to projects submitted to them for subsidization. Should it be the same market rate that is applicable to unsubsidized projects (which are privately funded in their entirety), or should some other rate be applied to reflect the partial funding by the government? As was indicated earlier, the issue turns on whether or not projects funded by the government are subject to the same risk premium that applies to privately funded projects. Some of the arguments that have been advanced on both sides of this question are considered briefly in this appendix. Although the discussion has been couched in terms of projects whose funding is entirely public, its implications are also pertinent to projects whose funding is shared – partly private and partly public.

Any innovation project necessarily involves the risk of failure. When the project is undertaken by a normal, risk-averse entrepreneur, this risk represents a cost for which compensation must be received. It has been suggested, however, that if some entity were to undertake a large number of projects such that the outcome of each, in itself subject to risk, would be independent of the outcome of each of the others, the risk inherent in the whole set of projects would be negligible. Hence the need to compensate for risk bearing would disappear. The only requirement that a given individual project would now have to meet, from the standpoint of the innovator, is that its expected rate of return exceed the risk-free discount rate. One entity that has been proposed for this purpose is, not surprisingly, the government.

Risk Pooling

The underlying argument, neatly summarized by McFetridge – which may be described as the risk-pooling approach – runs essentially along the following lines. The rates of return on statistically independent R&D projects are themselves statistically independent and randomly distributed. If the number of these projects is large enough, there will be little or no variation in the average rate of return on the portfolio of all the projects as a whole. This stability of the average rate of return on the portfolio means that little or no risk is assumed by whoever holds it. Risk therefore ceases to be a factor to be reckoned with in undertaking a specific R&D project, in spite of the fact that to undertake it is to risk failure. Clearly, then, it is in society's interests for R&D projects – indeed, risky projects of all types – to be undertaken by whoever is capable of undertaking a large number of them concurrently, be it the government or anyone else.

The validity of this argument depends critically upon the degree of statistical independence of the outcomes of the projects undertaken. If rates of return on projects have, for example, a high positive correlation, as they might have if they were heavily dependent upon the phases of the business cycle, then the variance of the average rate of return on a portfolio of projects would not tend to zero. This would imply that the average rate of return is not stable and is therefore itself subject to risk. Thus the cost of risk bearing would not be avoided by pooling and diversification.

Though not avoided altogether by pooling and diversification, this cost could, nevertheless, conceivably be reduced by them – and perhaps substantially. (Only in the extreme case of a perfect correlation of returns on projects will there be no cost reduction.) McFetridge thus considers whether institutions might therefore be expected to emerge in the market, whose function would be precisely to attain – by the taking of equity positions in a large number of projects – those reductions in risk premiums that pooling and diversification make possible. For such an institution, an equity position in any given project would be worthwhile, whatever the variance of the distribution of its own possible rates of return, as long as its expected rate of return exceeded the risk-free discount rate. He then proceeds to offer two reasons why this might not happen.

The first reason lies in the realm of moral hazard. If the risk-pooling institution assumes the entire risk attached to a given project, those charged with the actual running of the project may, because different incentives now exist, reduce the quality of their efforts, thereby reducing the project's expected rate of return. This reduced expected rate of return may lie below the risk-free discount rate – a result that would deprive the project of its attractiveness. McFetridge puts it well [p. 19]: "The dilemma here is that, unless risks are shifted, the project will not be undertaken. If they are shifted, the project will not be worth undertaking."

The second reason is the possibility that transactions costs would need to be incurred by the risk-pooling institution that could be so high as to bring the project's expected rate of return below the risk-free discount rate. The costs involved are of the type that would arise from the institution's monitoring of the progress of the project, as well as from the protection of its residual rights to its proceeds.

For McFetridge, these factors are sufficient to preclude effectively the possibility that the government would be a more efficient risk-pooling institution than a private one. The implication seems to be that both, being one remove from the actual performance of the work, would be subjected to equal burdens. This is plausible enough, but it leaves open the question of whether the actual performance of the work by the government – as opposed to the sponsoring of it – would serve to obviate most, though not all, of these costs. (This possibility is independent of the consideration that if the government performed many projects the very size of its scientific establishment might permit economies of scale not otherwise attainable.) Granted that the problem (noted earlier) of ensuring that the government's researchers and administrators maximize society's interests rather than their own would still remain, the possibility does exist that risk pooling, in the context of governmental innovative activity, would increase the number of projects worth undertaking.

There is another factor to be considered in addition to the problems of moral hazard and transactions costs, which may explain the failure of private risk-pooling institutions to emerge in the market, even though the attainable reductions in risk premiums on projects would enable their expected rates of return to exceed the risk-free discount rate. The foregoing discussion involved the taking by the risk-pooling institution of an equity position in a *project*. Firms, however, have not hitherto been able to go into financial markets to sell shares in specific projects that they propose to undertake, be they R&D projects or any other. What they must offer is shares in *themselves as entities*. Such a constraint may suffice to deter (notwithstanding the merit of the project in question) both the would-be innovative firm and the would-be risk-pooling institution. For the former, issuing shares to finance the project may weaken or remove the degree of control possessed by its controlling shareholders. For the latter, it is obliged to buy a share in all of the firm's other activities – a prospect that may be less inviting than the support of the specific project. Thus the possibility cannot be excluded that this form of market failure may suffice to prevent otherwise worthwhile projects from going ahead.

Risk Spreading

Using a different approach, called the time-state-preference approach, Hirshleifer (1966) presents an alternative view of the issue of government financing of projects undertaken in the face of uncertainty by decision makers who are risk-averse. In this model only the situation in the current period is known for certain. Otherwise, decision makers must make choices between future time periods in which the state of the world has two alternative, mutually exclusive, conditions, each of which has its own probability. The relevant question for present purposes [p. 268] is: "What is the 'appropriate' discount rate, for use under uncertainty, in present-worth calculations evaluating government investments not subject to the market test?" More precisely, Hirshleifer asks whether government projects should be subjected to the same discount rates that a private firm would apply to comparable, risky projects or whether they should be subjected to (lower) risk-free discount rates, on the grounds that the government can eliminate risk through pooling. The answer that he develops, on the basis of the time-state-preference model, is that, given the existence of perfect markets in which all types of claims to income in future states can be traded freely, comparable projects should be discounted at the same "risky" rate whether they be undertaken privately or by the government. He acknowledges, however, the possibility that market imperfections preventing this trade from taking place freely may in reality be very prevalent.

Hirshleifer further suggests that it would be appropriate for the government to subsidize risky projects undertaken by firms that are less able to pool independent risks than the government. These subsidies would, in his view, enable such firms to proceed with projects whose risk-adjusted expected rates of return would otherwise be unacceptably low. He also suggests that it would be inefficient for the government to utilize its access to risk-free rates of interest to borrow in order to undertake projects itself at the margin, when the funds involved might instead have enabled projects with higher expected rates of return to be undertaken in the private sector. Integral to this analysis is the notion that risk pooling itself is not always justified. If a project that bears fruit in a state when the fruit is valued highly is pooled arbitrarily with a project whose pay-off is less highly valued, the result may be to bring into being an inefficient package of projects. In other words, projects capable of being undertaken separately should be evaluated separately, and the discounting should be at market rates.

Although they also adopt the time-state-preference approach, Arrow and Lind (1970) arrive at conclusions that differ quite sharply from those of Hirshleifer. They grant that public-sector projects undertaken on the basis of risk-free discount rates may serve to displace private-sector projects having higher expected rates of return, but they do not necessarily see this as objectionable. The critical issue for them is whether or not society as a whole is rendered better off as the result of the public-sector project – on the basis, say, of the Hicks-Kaldor criterion, whereby the government could, if it chose, more than compensate private entrepreneurs for their opportunity costs. Second, as for Hirshleifer's suggestion that the government subsidize certain private-sector projects, they argue that these subsidies would not reduce the cost of risk bearing, since the risks borne by the private entrepreneurs remain undiminished. The subsidies might therefore make it possible for inefficient projects to be undertaken in the private sector. Instead of subsidies, which, in their view, fail to eliminate the cost of risk bearing, they favour government programs that insure the risks assumed by private entrepreneurs.

Arrow and Lind suggest that the necessary insurance services are unlikely to be provided by private institutions, for two reasons. The first reason is the familiar problem of moral hazard; the second reason, also familiar, is the high transactions costs that would arise from the complex contractual arrangements that would be required.

The important question, however, is whether the cost of risk bearing is in fact avoidable when projects are undertaken in the public, rather than the private, sector. For Arrow and Lind it is indeed avoidable, not on risk-pooling but on *risk-spreading* grounds. Their argument is that a risky government project financed by taxes would, because the community consists of a great many individuals, impose upon each person a risk premium that approaches zero. In other words, in a large community the expected rate of return on a risky project undertaken by the government approaches the expected rate of return earned by a risk-free project. Although it is difficult to estimate the large number of taxpayers required, it is likely that the cost of risk bearing to each taxpayer is negligible when each taxpayer's outlay for a given project is a negligible proportion of his income. If the project were sponsored by the national government, the number of taxpayers would presumably be large enough to satisfy the requirements of this argument. In addition, even if the project were a large one in absolute terms, it would generally represent only a small fraction of national income.

Arrow and Lind acknowledge that their argument depends upon the return from a given government project being independent, not only of the returns from its other projects but also of other components of national income. If, however, some of these projects are interdependent, they should be evaluated as a group: there will still remain many independent projects or groups of projects. As for the situation where the return from a given project is positively correlated with components of national income, the important question in their view is the extent of that correlation – whether it is high enough to fail to eliminate the cost of risk bearing.

Arrow and Lind also consider the question of whether a project undertaken by a large corporation with many shareholders could be said to entail risk spreading if the project were small in relation to the combined income or wealth of the shareholders. They identify two factors likely to contradict a risk-spreading view of corporate investment behaviour. First, the shareholdings may not be sufficiently dispersed, however many shareholders there are. In order to have control of the corporation some shareholder may hold a block of shares that represents a significant proportion of his income or wealth. Second, investment decisions of firms are generally made by managers, not by shareholders. They cannot afford to neglect risk, since their personal interests are closely tied to the firm's performance. Hence they may be reluctant to discount prospective projects on a risk-free basis, irrespective of the number of the firm's shareholders and the distribution of their shareholdings.

McFetridge takes issue with the main conclusions drawn by Arrow and Lind. His first objection [p. 20] is that:

> "... if the outcome of a risky venture is positively correlated with a taxpayer's other income, it can not be shown that the latter will be willing to bear even a very small risk at no cost. Thus, if the returns to all projects are not independent, it is technically impossible to eliminate risk either by risk-pooling or by risk-spreading."

Arrow and Lind deal with this consideration in two ways. First, they submit that it does not arise at all if stabilization policies are successful. (They point out that in most benefit/cost studies it is assumed that full employment will be maintained, so that market prices can be used to measure benefits and costs. Thus consistency requires that the full-employment assumption also be applicable to the evaluation of risk.) Second, they insist, as mentioned above, that the important question, even if this positive correlation exists, is whether its extent is sufficient to invalidate their argument.

As a practical matter, this last justification appears to have a good deal of validity, as it did in the context

of the risk-pooling discussion. Even if the degree of positive correlation were enough to impose upon each taxpayer a nontrivial cost of risk bearing arising from a given public-sector project, this cost might still be substantially less than that which a private entrepreneur would have to contemplate in relation to that same project. It might therefore be in society's interests for the project to be undertaken publicly, if the above-mentioned Hicks-Kaldor considerations apply. To argue, then, that the issue turns on the *elimination* rather than reduction by government action, of the cost of risk bearing is to impose a test that is too stringent.

McFetridge's second objection [pp. 20-21] involves basically the problems of moral hazard and transactions costs.

> "... if the aggregate cost of risk-bearing can be reduced by a wider spreading of the ownership of a risky venture, there is obviously scope for a mutually beneficial exchange between owners and non-owners. One might expect that, subject to the limitations of moral hazard and transactions costs, a market would arise to effect such exchanges. Since the type of risk-spreading described by Arrow and Lind forces all taxpayers to undertake a risk bearing function whether or not they would have chosen to do so, it must be regarded as inferior to the risk-spreading effected by the market, unless it can be shown that state risk-spreading avoids some of the moral hazard and transactions costs to which market exchanges are subject."

The essential points involving markets in which the relevant claims are exchanged have already been discussed. Equity claims are residual claims against the net assets of firms, not against the fruits of specific projects. Even if this were not a sufficient limitation, there would still remain the difficulty that the decisions to proceed or not to proceed with specific projects rest, in a corporation of any size, with managers and not with shareholders. Their different sensitivities to the costs of project failure, compared with those of shareholders, may in themselves rule out the emergence of such a market. As for the government's arbitrary imposition upon taxpayers of the costs of risk bearing, this, it must be admitted, is a not-unimportant consideration, even if those costs are slight. Whether it is inherently any more objectionable than the levying of any other tax is, however, by no means apparent. In any case, the question requires an analysis that is beyond our present scope. Such an analysis would also have to consider whether Hicks-Kaldor conditions exist to justify the imposition.

McFetridge advances his third objection [p. 21]: that the possibility exists that either, or both, of the costs and benefits of a given project may accrue to subsets of taxpayers. In particular,

> The benefits of industrial R&D will be confined to those who perform it and to those using the new product or products produced by the new processes which result from this R&D .... This may be a relatively small number of individuals and the benefits involved may constitute a relatively large fraction of their wealth. In this case the benefits should be discounted at the relevant private sector rate.

This is a valid argument, as Arrow and Lind recognize. They, however, discuss it in rather more comprehensive terms. Their fundamental view, in summary, is that a public-sector project will, in general, involve benefits and costs that accrue partly to the government (i.e., to all taxpayers) and partly to reasonably well-defined subsets of taxpayers. For those benefits and costs that are garnered and borne publicly, the cost of risk bearing is negligible and should be disregarded. For those that are garnered and borne privately, the possibility exists that there is a significant cost of risk bearing to be reckoned with. Assuming that there are no insurmountable identification problems, the latter streams of benefits and costs should be discounted on the basis of private preferences. Although there may be problems because of aggregating private benefits and costs, a reasonable way to accomplish this would be to find and apply to these streams the marginal rates of return on assets having similar pay-offs in the private sector.

The foregoing implies that public-sector projects will still tend to emerge with higher, risk-adjusted, discounted expected rates of return than would corresponding private-sector projects – and all the more so if the (private) subsets of taxpayers are large. This last consideration may be of particular importance. It suggests that, in general, the government should strive to avoid undertaking projects whose prospective benefits are confined to relatively few individuals and should favour projects with many potential beneficiaries.

The essential finding of the Arrow-Lind analysis with respect to risk spreading thus appears to stand. The returns to certain projects should be subjected to a lower discount rate when undertaken publicly than when undertaken privately. The difficulties that inhibit the development of markets for the trading of private contingent claims bearing differently assessed risk factors are substantial and probably intractable. Hence it may well be efficient for the government to undertake (but not necessarily subsidize) these projects if private entrepreneurs have not found them worthwhile (or, alternatively, to induce private entrepreneurs to undertake them by insuring their outcomes). In a Canadian context, the projects in question would probably need to be federal ones

whose benefits are distributed over at least several regions.

Summing Up

This is not the place to attempt to resolve all of the issues raised in the foregoing. Some of them – such as whether subsidies or insurance coverage are the more efficient governmental instruments for reflecting its risk-spreading capability – though important in themselves, are secondary to the fact of agreement that the government has this capability, at least to a degree that could not readily be matched by a private agency. It seems clear that there do exist certain institutional constraints that impede the emergence of private institutions whose *raisons d'être* would consist of taking equity positions in large numbers of risky projects, so that the cost of risk bearing becomes negligible – or if it does not become negligible, it at least diminishes significantly. The government seems to be free of these particular constraints, although it is no less susceptible to the problem of moral hazard and the burden of transactions costs. On the whole, it would be reasonable, as suggested earlier, for subsidy program administrators to operate on the principle that the proportion of the stream of a subsidized project's returns given by the proportion of its total cost represented by the subsidy should be discounted at a lower, though not necessarily risk-less, rate than the market rate applicable to the remaining proportion.

B The Impact of EDP Subsidies upon the R&D Spending of Firms

Apart from its intrinsic interest, the question of the direction and magnitude of the impact of R&D subsidies upon the autonomous R&D spending of the subsidized firms has critical significance for the administrators of subsidy programs in their efforts to assess the efficacy of their programs. Unless there exist reasonable grounds for believing that the subsidies augment, to the approximate degree intended, the R&D spending of the recipient firms, it becomes very difficult to sustain the judgment that the programs are in fact achieving their goals of bringing about higher levels of socially desirable innovative activity in the economy than would otherwise prevail. (The existence of such grounds would not in itself suffice to validate this judgment, as was shown in Chapter 1, but their absence would certainly preclude it.)

The primary purpose of this appendix is to illustrate (by drawing upon previous, analogous attempts to do so with respect to other subsidy programs) how the foregoing question *might* be addressed with respect to EDP. Although this illustration will be presented in both conceptual and empirical terms, its illustrative character should be borne in mind. There is no suggestion – and this will be confirmed by the discussion of its possible limitations – that it should necessarily be adopted as the precise means whereby the administrators of EDP (or of any other subsidy program) could estimate the annual impact of their program's subsidies upon the R&D behaviour of the recipient firms. But if it does not ultimately qualify as *the* mechanism with which this estimate can be made with adequate confidence, the specification considered in this illustration will probably be seen (after more work has been done in the area) to contain some useful elements of that mechanism.

Specifying the Relationship in Estimable Form

The impact of the subsidies upon the R&D spending of the recipient firms can only be examined within a context that takes account of all the other factors that have a significant, systematic bearing upon that spending. As was indicated in Chapter 1, the issue with respect to an individual firm can be expressed notationally along the following lines:

$$R_{it} = a_0 + \sum_{j=1}^{n-1} a_j V_{jit} + a_n G_{it} + \epsilon_{it},$$

where R_{it} = R&D spending from its own funds by the i^{th} firm during year t;
V_j = each variable, other than subsidies, that bears systematically upon R_{it};
G_{it} = total subsidies received by the i^{th} firm during year t; and
ϵ_{it} = random disturbances.

Although some work has been done on the subject of the determinants of firms' R&D spending, most of it refers to the U.S. scene [see, for example, Grabowski (1968) and references cited therein]. Only the limited research relating to Canada includes subsidies among the determinants: indeed, it was the existence of the subsidies that apparently prompted the research. Since the latter research is obviously the more pertinent and stands, so to speak, on the shoulders of its U.S. predecessors, our discussion will be largely confined to it.

One of the first Canadian attempts to model the determinants of the R&D spending of subsidized firms, and to estimate the impact upon that spending of the subsidies was made by Howe and McFetridge.[1] They began by recognizing that, like investment spending generally, firms' spending on R&D can theoretically be expected to continue to the point where the marginal rate of return on R&D spending equals the marginal cost of funds. In their model, they point out, however, that it is not yet possible, first, to specify all the variables that systematically impinge upon these two marginal values and then, having equated both sets of variables, to solve and estimate the resulting reduced-form equation. Instead, they specify the following cubic equation:

$$R_{it} = a_0 + a_1 S_{it} + a_2 S_{it}^2 + a_3 S_{it}^3 + a_4 P_{it} + a_5 A_{it} + a_6 G_{it} + a_7 H_i + \epsilon_{it},$$

where R_{it} = R&D expenditures of the i^{th} firm during year t, excluding innovation subsidies and R&D done under contract;
S_{it} = sales of the i^{th} firm during year t;

P_{it} = profits after taxes but before deduction of R&D expenditures of the i^{th} firm during year t;
A_{it} = depreciation expense of the i^{th} firm during year t;
G_{it} = total innovation subsidies received by the i^{th} firm during year t;
H_i = Herfindahl (concentration) index of the three-digit industry to which the i^{th} firm is assigned; and
ϵ_{it} = random disturbances.

Shortly thereafter, McFetridge applied a slightly modified version of this model to a different sample of firms subsidized under IRDIA between 1967 and 1971. (Howe and McFetridge had studied a sample of firms subsidized collectively under PAIT, IRAP, DIPP, and the Defence Industry Research Program, DIRP.) McFetridge, however, dropped the H_i variable from his specification, presumably because Howe and McFetridge had found it to be insignificant in regard to two of the three industries examined. Since it is this latter specification that has been applied to data pertaining to EDP, its underlying rationale requires a word.

Consider first the sales variables. It is hypothesized that firms' own R&D spending tends to vary with sales, initially at an increasing rate and ultimately at a decreasing rate. There are a variety of influences at work that tend to render own-R&D spending an increasing function of sales. It has been argued, for example [see Nordhaus (1967)], that the optimal value of R&D spending increases with a firm's sales. In addition, larger, diversified firms can presumably find more profitable internal applications for the fruits of their R&D spending than smaller ones can; and sales are an excellent measure of firm size. Similarly, a larger firm is more likely to command a larger market share and hence can probably appropriate unto itself a larger proportion of the benefits generated by its innovations than a smaller firm can. In view of the variegated impacts that sales can thus have upon the R&D behaviour of firms, the cubic form is specified so as to capture the overall relationship involved.

It is also hypothesized that both a firm's after-tax profits and its cash flow (the sum of its after-tax profits and its annual depreciation/depletion expense) have a systematic bearing upon its R&D spending. That bearing is therefore specified in terms of the separate impacts of the profits and the depreciation/depletion expense. The main reason that the profits effect is specified separately from the cash-flow effect is that profits can be regarded as the current return to previously invested capital, including intangible R&D capital. Consequently, the higher the current return, the higher the future returns on current R&D spending; hence, the higher the spending. Both effects are assumed to be linear, as a matter of convenience, as is the impact of innovation subsidies received by the firms.

The relevance of cash flow, admittedly lagged one year, was postulated earlier by Grabowski, although he did not specify profits separately. Nor were sales specified in a form comparable to the above. On the other hand, he attributed a systematic, linear influence to the number of patents that firms were awarded annually per scientist and engineer, and also to an index of the degrees to which firms were diversified. This last could be seen as serving a purpose that is somewhat analogous to that of a sales variable, since a firm's diversification is likely to reflect its size.

Each of these specifications (and, no doubt, others that could be conceived) has its own conceptual legitimacy. Discretionary investment in R&D, like any other form of capital formation, takes place when the investor expects that it will bring him future benefits that, discounted, will justify his present costs. Such an expectation depends, however, upon a great many factors, reflecting both general economic expectations for the relevant future period and expectations pertaining to the specific markets served by the projected innovation. Given that so many industrial products are intermediate goods (not infrequently, several times over), reckoning with the various derived-demand considerations that are relevant to one degree or another and subject to a variety of lags is no mean feat. To all this must be added those factors which are, so to speak, indigenous to the firm's situation, both as an entity and as a member of an industry. For example, a good research team is not easily or quickly assembled. Hence, once assembled, its very existence requires that it be kept busy with activities that go beyond make-work activities; otherwise, its more talented members will before long seek more creative outlets for their energies, perhaps with rival firms. Similarly, firms have market shares to protect and, if possible, enhance. Their rivals therefore cannot be allowed to develop or, if developed, to maintain undue superiority over what might be termed innovative potential. It is also arguable that a firm's previous history vis-à-vis subsidy-awarding agencies may have a bearing upon its current R&D behaviour. For example, it may be felt that its past R&D performance had a positive effect upon its eligibility for subsidies. Thus its current level of R&D spending may similarly enhance its present and future subsidy prospects.[2]

Clearly, the specification of variables that could theoretically exert a systematic influence upon a firm's own R&D spending is an especially problematic

aspect of the specification of its general investment behaviour – an exercise whose difficulty is generally recognized. The only sensible course of action for subsidy program administrators to adopt, at this stage, is to proceed cautiously but empirically – to test various seemingly plausible specifications against the data and see which has the most explanatory power.

The following results were obtained when the McFetridge model was estimated on the basis of a sample of EDP subsidies to firms in the two industries that received the most subsidies since the inception of the Program: electrical products, and machinery and equipment.[3]

Modified Howe-McFetridge Model

Electrical Products

$$R = \underset{(0.11)}{-\ 244.54} + \underset{(3.31)}{0.04S} - \underset{(1.62)}{7.55(10)^{-10}S^2} + \underset{(0)}{3.30(10)^{-18}S^3} + \underset{(2.27)}{0.07P} + \underset{(3.25)}{0.79A} + \underset{(0.34)}{0.65G1} + \underset{(3.06)}{0.47G2}$$

$\bar{R}^2 = 0.72$; $N = 96$; $F = 24.26$.

Machinery and Equipment

$$R = \underset{(0.369)}{13.01(10)^{3}} - \underset{(0.45)}{0.01S} + \underset{(0.67)}{1.12(10)^{-9}S^2} - \underset{(0.77)}{3.43(10)^{-17}S^3} + \underset{(2.21)}{0.07P} + \underset{(4.15)}{0.25A} + \underset{(0.19)}{0.52G1} + \underset{(2.91)}{0.63G2}$$

$\bar{R}^2 = 0.57$; $N = 88$; $F = 10.66$.

Note $G1$ = Non-EDP subsidies; $G2$ = EDP subsidies; and t-ratios appear in brackets.

It is the coefficients of $G2$ that are most relevant in the present context. To begin with, we can reject, at a high-confidence level, the hypothesis that EDP subsidies have had no impact upon recipient firms' discretionary R&D spending in both industries. These coefficients indicate that each dollar of EDP subsidies paid induced, on average (between 1977 and 1980), increases in such spending of 47 cents and 63 cents in the electrical products and machinery and equipment industries, respectively. While there is definite comfort in having an empirical basis for the judgment that, unlike certain other subsidy programs,[4] EDP has been having a positive effect upon recipient firms' own R&D spending, it is not possible unambiguously to assess the adequacy of that impact, given what we know about the Program's *modus operandi*. We can infer, for example, that most EDP subsidies paid during this period were intended to cover half of the costs of the subsidized projects. We also know that, however inadequate the criteria relied upon, every subsidized project was intended to be fully incremental to the firm. Since both of the estimated coefficients are less than unity, it is clear that the latter intention has not been entirely fulfilled. What is not clear, however, is the size of the gaps between the achieved amounts of induced R&D spending and the amounts that might reasonably have been expected on the basis of a more efficient decision rule than the significant-burden criterion. Had the decision rule developed in Chapter 1 been adopted, it would have been possible to postulate, along the lines indicated there, the optimal amount of induced R&D spending. This possibility is precluded by the significant-burden criterion, which is only capable, at best, of implying that a project that represents a higher proportion of a firm's own resources is perhaps more likely to be incremental to it than a project representing a lesser proportion. The shortcomings of this approach have already been enumerated and need not be repeated here. The main purpose of this appendix can be served by observing that models along the lines of Howe-McFetridge seem to qualify as workable first approximations of reality. A secondary, but important, purpose is served by suggesting that substantial proportions of EDP subsidies appear to have been used by recipient firms as replacements for, rather than additions to, their own R&D spending. This, in turn, suggests that the Program's decision-making procedures with regard to subsidies are in need of revision, preferably in conformity with the relevant discussion in Chapter 1.

C Internal Departmental Evaluations of the Effectiveness of PAIT

We begin with the single evaluation that covered the years 1965 to 1971, inclusive, whose findings are reflected in Tables C-1 and C-2. It is on the basis of those two tables that this report's discussion turns with respect to the question of the Program's effectiveness. Consider first the 95 completed projects, of which 38 are reported as failures and 57 as successes, starting with the former. The 40 per cent failure rate was investigated by the report's authors. They elicited the information that some two-thirds of the unsuccessful projects failed for commercial rather than technical reasons, and they therefore rightly expressed approval of the recent changes in the Program that permitted the subsidization of the costs of market studies.

Table C-1

Program for the Advancement of Industrial Technology: Active and Completed Projects, Fiscal Years 1965/66 through 1970/71

	Number of projects	PAIT commitment	Estimated sales
		($ Millions)	
Active projects	274	81.4	3,770*
Completed projects			
Successful	57	5.3	230
Unsuccessful	38	3.3	--
Total	369	90.0	4,000

*PAIT II projects only.
SOURCE Based on data from the Department of Industry, Trade and Commerce.

More interesting (and more disturbing, however) is the approach adopted towards "successful" projects. (Failed projects are in a sense easy to identify, if not to explain: they are projects that have not produced any sales and are not expected to do so in the future. They are, presumably, in most cases projects that were aborted at one stage or another.) Table C-2 sets out the factors that the authors of the report considered relevant to success *from the standpoint of the Program*: projected sales, projected capital formation, and increases in employment in R&D and in production. It hardly needs saying that projected sales, by themselves, are an entirely insufficient indicator of program effectiveness, especially if not accompanied by information on projects' costs, profits, and rates of return. It is also noteworthy that no attempt seems to have been made to discount these projections, at some rate, to derive their present values, nor was any attempt made to allow for the effects of inflation. Similarly, without some attempt to incorporate some notion of incrementality – at any level, let alone at the level of the economy – any talk of "increased" investment or employment attributable to the projects in question is meaningless. So, all in all, this report is of little value, not only because it provides inadequate or incomplete information, but above all because of a systematic failure to even raise the sorts of questions whose answers would enable policy makers to begin to assess the efficacy of the Program.

Table C-3 refers to the years up to the end of PAIT's 1971/72 fiscal year, and it is useful to let the report for that year speak for itself.

> The above data show that the ratio of benefits to PAIT commitment is increasing and that, based on the present analysis, every million dollars in PAIT expenditure is expected to generate $31 Million in sales (Canadian content of $26 Million and export sales of $23 Million), $1.8 Million in capital investments, and 160 new employment opportunities in R&D and manufacturing.
>
> If the above relationships are extrapolated to the entire Program expenditure to March 31, 1972 ($61.5 Million), it will be found that this expenditure will generate about $2 Billion in sales over a five-year period, $110 Million in capital investments, and 9,800 new employment opportunities in R&D and manufacturing. [See Department of Industry, Trade and Commerce (1972), p. 8.]

Here, again, the same mentality is at work – only now, with some new refinements. In addition to projected-sales/PAIT ratios, "success" is now also expressed – along with the familiar "increases" in investment and employment – in terms of (undefined) Canadian-content/PAIT-dollars and export-sales/PAIT-dollars ratios, and PAIT dollars per job. Once again, there is no visible discounting or allowance for the fact that, during inflation, the respective dollars of the successive years of the projections represent different amounts of purchasing power and, therefore, are not to be aggregated at nominal value.

Table C-2

Program for the Advancement of Industrial Technology: Completed Projects, Fiscal Years 1965/66 through 1970/71

	Number of Projects	PAIT share	Estimated impact of PAIT over five years: Sales	Capital investment	Increase in employment: R&D	Increase in employment: Mfg.	Repayments* to March 31, 1971
			($ Millions)		(Jobs)		($ Thousands)
Completed projects:							
Successful	57	5.3	230**	9.5	69	699	539.3
Unsuccessful	38	3.3	--	--	--	--	--
Total	95	8.6	230	9.5	69	699	539.3

*All projects completed to December 31, 1970, were PAIT I projects and subject to repayment.
**Actual sales to November 30 1970, amounted to $26 million.
SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table C-3

Program for the Advancement of Industrial Technology: Completed Projects, Fiscal Year 1971/72

	Number of projects	PAIT share	Estimated impact of PAIT over five years to 1976: Sales	Capital investment	Increase in employment: R&D	Increase in employment: Mfg.	Repayments to March 31, 1972
			($ Millions)		(Jobs)		($ Thousands)
Completed projects:							
Successful	75	8.5	530	31	104	2,609	827
Unsuccessful	101	8.5	--	--	--	--	--
Total, as of 1971/72	176	17.0	530	31	104	2,609	827
					2,713		
Total, as of 1970/71	95	8.6	230	9.5	768		539
				(Per cent)			
Percentage increase over previous year	85	97	130	227	253		53
Ratio to PAIT dollars:							
Estimated sales			31:1				
Canadian content			26:1				
Export sales			23:1				
					(Dollars)		
PAIT dollars per job					6,236		
							(Per cent)
Proportion of PAIT dollars recovered							4.8

SOURCE Based on data from the Department of Industry, Trade and Commerce.

But by far the most serious objections to this approach stem from the fact that these variables do not, and cannot, even begin to serve, in isolation from some notion of incrementality, as indicators of the degree to which the Program has accomplished its primary objective of fostering the growth and efficiency of Canadian manufacturing and processing industries. Most of these shortcomings have already been identified with respect to the projections of future sales, investment, and employment: the new variables fare no better. This report implicitly argues that it is in Canada's interests for the government to subsidize projects that maximize "Canadian content," as well as exports. The validity of neither objective is obvious – examples could easily be conjured up to demonstrate that imports will, under certain conditions, contribute more to Canadian welfare than domestic production. Indeed, even in the rather unlikely event that a PAIT subsidy satisfied the conditions developed earlier for legitimate subsidization of R&D, that legitimacy would diminish in direct proportion to the degree to which the consumers' surplus generated by the subsidy went to foreigners. What we seem to have here is evidence that the possibility, noted earlier, of inconsistency between the Program's main objective and at least some of its subobjectives did not arise in the minds of its administrators. Finally, what could usefully be learned from the PAIT dollars-per-job figure presented in this report?

Apart from more up-to-date figures, there is, with one rather intriguing exception, little more to be derived in the way of genuine program evaluation from the 1972/73 report. This exception involves a passing reference to a forthcoming exercise whereby "the data on individual completed projects will be run through a formal benefit/cost model in order to arrive at a more comprehensive discounted result for the completed program." This reference follows another that recognizes that PAIT contributions are only one of many factors that ultimately produce sales. It appears, however, that this exercise was either never begun or, if begun, never completed. The mere fact, however, that it was contemplated implies that some uneasiness was felt that the concepts and indicators hitherto relied upon might be less than adequate.

Whatever the misgivings that prompted this abortive benefit/cost exercise, apparently, they were successfully suppressed, during PAIT's remaining life, within the minds of the officials charged with monitoring and evaluating the Program. Neither of their last two annual reports – for the years 1973/74 and 1974/75 – give evidence of methodological ambivalence. Instead, both documents are, with minor variations, cast essentially in the mould of their predecessors, as Table C-4 shows.

Table C-4

Program for the Advancement of Industrial Technology: Completed Projects, Fiscal Year 1974/75

	Number of projects	PAIT share	Estimated impact of PAIT over five years to 1979			PAIT I repayments	
			Sales	Capital investment	Increase in employment		
			($ Millions)		(Jobs)	$ Thousands	
Completed projects:							
Successful	192	36.6	2,033	43	4,054	(Principal)	414
Unsuccessful	227	22.8	--			(Interest)	984
Total, as of 1974/75	419	59.4	2,033	43	4,054		1,398
Total, as of 1973/74	342	49.4	1,496	77	4,426		1,398
				(Per cent)			
Percentage of increase over previous year	23	20	36	..	..		..
Ratio of estimated sales to PAIT dollars			34:1		(Dollars)		
PAIT dollars per job					14,600		

SOURCE Based on data from the Department of Industry, Trade and Commerce.

D Statistical Appendix

Table D-1

Program for the Advancement of Industrial Technology: Commitments and Expenditures, by Industry Group, End of Fiscal Year 1974/75

Industry group*	Estimated total cost of project	PAIT commitments		PAIT expenditures	Total projects		Average PAIT commitment
		Amount	Distribution		Number	Distribution	
	($ Thousands)		(Per cent)	($ Thousands)		(Per cent)	($ Thousands)
Mines	27,254	13,628	5.8	7,909	23	2.6	593
Gas and oil wells	12,818	6,409	2.7	5,343	6	0.7	1,068
Food and beverages	9,185	4,564	1.9	2,337	53	6.1	86
Rubber	1,076	538	0.2	300	9	1.0	60
Textiles	6,289	3,274	1.4	2,114	18	2.1	182
Wood	2,463	1,232	0.5	972	10	1.1	123
Furniture	350	175	0.1	144	2	0.2	88
Paper	11,751	5,853	2.4	3,328	26	3.0	225
Primary metals (ferrous)	13,222	6,612	2.7	3,880	18	2.1	367
Primary metals (nonferrous)	5,035	2,516	1.1	1,289	9	1.0	280
Metal fabricating	16,429	8,133	3.4	4,712	61	7.0	133
Machinery	99,086	49,522	20.9	16,897	140	16.1	354
Aircraft and parts	26,213	13,883	5.8	11,973	15	1.7	926
Other transportation equipment	26,650	13,189	5.5	7,495	52	5.9	254
Electrical products	119,794	60,757	25.7	43,417	139	16.0	437
Mineral products	6,005	3,002	1.3	1,760	19	2.2	158
Petroleum products	2,582	1,292	0.5	862	4	0.5	323
Drugs and medicines	5,313	2,657	1.1	615	14	1.6	190
Other chemical products	36,122	17,494	7.4	8,868	70	8.0	250
Scientific instruments	11,317	5,833	2.4	4,711	47	5.4	124
Other manufacturing	9,863	4,947	2.1	3,175	67	7.7	74
Utilities	8,732	1,842	0.8	1,173	13	1.5	142
Nonmanufacturing	17,066	10,278	4.3	7,781	57	6.5	180
	474,614	237,630	100.0	143,055	872	100.0	273

*Statistics Canada categories.

SOURCE Based on data from the Department of Industry, Trade and Commerce

Table D-2

Program for the Advancement of Industrial Technology: Commitments and Expenditures, by Province, End of Fiscal Year 1974/75

	Estimated total cost of project	PAIT commitments		PAIT expenditures	Total projects		Average PAIT commitment
		Amount	Distribution		Number	Distribution	
	($ Thousands)		(Per cent)	($ Thousands)		(Per cent)	($ Thousands)
Newfoundland	–	–	–	–	–	–	–
Nova Scotia	2,606	1,304	0.5	293	11	1.3	118.5
New Brunswick	831	415	0.2	257	4	0.4	103.7
Prince Edward Island	391	195	0.1	47	3	0.3	65.0
Quebec	138,428	68,866	29.0	35,492	231	26.5	298.1
Ontario	263,779	131,126	55.2	81,731	462	53.0	283.8
Manitoba	3,771	1,885	0.8	1,384	15	1.7	125.7
Saskatchewan	1,105	552	0.2	409	6	0.7	92.0
Alberta	16,369	8,092	3.4	5,883	46	5.3	175.9
British Columbia	47,335	25,192	10.6	17,462	94	10.8	268.0
Total	474,615	237,627	100.0	143,055	872	100.0	272.5

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-3

Program for the Advancement of Industrial Technology: Project Cost Distribution (Average and Median Values), End of Fiscal Year 1974/75

	Number of projects					
		PAIT II				
	PAIT I	To March 31, 1972	1972/73	1973/74	1974/75	Total
PAIT commitment (dollars):						
5,000 - 50,000	87	58	32	21	19	217
50,001 - 100,000	59	85	31	31	20	226
100,001 - 200,000	36	75	27	35	24	197
200,001 - 300,000	13	33	21	11	13	91
300,001 - 400,000	3	25	10	7	7	52
400,001 - 500,000	2	8	4	4	1	19
500,001 - 1,000,000	4	18	11	6	3	42
1,000,001 - 2,000,000	1	8	1	2	2	14
2,000,001 - 3,000,000	–	–	–	3	1	4
3,000,001 - 4,000,000	–	2	–	–	–	2
4,000,001 - 5,000,000	–	1	1	1	1	4
5,000,001 - 10,000,000	1	1	–	–	–	2
10,000,001 - 20,651,467	–	1	–	1	–	2
	206	315	138	122	91	872
			(Dollars)			
Average PAIT share	145,000	307,000	237,000	442,109	267,010	273,000
Median value	60,000	118,000	122,000	113,625	108,322	97,000

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-4

Program for the Advancement of Industrial Technology: Completed Projects, by Company Size (Sales), End of Fiscal Year 1974/75

	PAIT expenditures		Actual sales		Projects	
	Amount	Distribution	Amount	Distribution	Number	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)		(Per cent)
Project results, by company size (sales in $ thousands):						
No sales						
Successes	2,614.4		7,099.0		13	
Failures	2,585.3		2,950.0		22	
Subtotal	5,001.7	8	10,049.0	3	35	8.4
1 - 999						
Successes	3,730.8		13,099.8		51	
Failures	3,463.0		3,482.0		60	
Subtotal	7,193.8	12	16,581.8	4	111	26.5
1,000 - 9,999						
Successes	6,929.9		46,145.6		68	
Failures	4,094.0		1,600.0		55	
Subtotal	11,023.9	19	47,745.6	13	123	29.3
10,000 - 49,999						
Successes	9,877.7		66,710.3		32	
Failures	3,971.9		65.0		57	
Subtotal	13,849.6	23	66,775.3	18	89	21.2
50,000 - 74,999						
Successes	1,091.1		6,600.0		3	
Failures	1,256.2		-		7	
Subtotal	2,347.3	4	6,600.0	2	10	2.4
75,000 +						
Successes	12,522.9		226,663.7		25	
Failures	7,444.2		-		26	
Subtotal	19,967.1	34	226,663.7	60	51	12.2
Total	59,383.4	100	374,415.4	100	419	100.0

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-5

Program for the Advancement of Industrial Technology: Completed Projects, by Nationality of Company Ownership, End of Fiscal Year 1974/75

	PAIT expenditures		Actual sales		Ratio of sales to PAIT dollars	Projects	
	Amount	Distribution	Amount	Distribution		Number	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)			(Per cent)
Project results. by company ownership:							
U.S.-owned							
Successes	12,837		188,902		15:1	32	
Failures	7,092		–			45	
Subtotal	19,929	34	188,902	50	9:1	77	18
Foreign-owned (other than U.S.)							
Successes	1,565		10,170		6:1	10	
Failures	983		–			10	
Subtotal	2,548	4	10,170	3	4:1	20	5
Canadian-owned (incl. Crown corporations)							
Successes	22,166		167,246		8:1	150	
Failures	14,740		8,097		0.5:1	172	
Subtotal	36,906	62	175,343	47	5:1	322	77
Total	59,383.4	100	374,415	100	6:1	419	100

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-6

Enterprise Development Program: Contribution Project Distribution, by Industry Group, Fiscal Years 1980/81 and 1981/82

	1980/81			1981/82		
	Number of projects	Project cost	Authorized amount	Number of projects	Project cost	Authorized amount
Industry group:						
Gas and oil wells	1	2,140,483	1,070,241	–	–	–
Food and beverages	28	3,321,219	4,302,915	22	2,774,258	1,461,331
Rubber and plastics	32	4,497,469	2,785,594	10	651,003	457,673
Textiles	[illegible]	382,595	280,195	11	543,462	381,220
Clothing	3[illegible]	1,448,963	1,031,015	22	645,864	474,647
Footwear	2[illegible]	908,710	712,182	1	24,500	18,375
Wood	12	473,431	355,073	22	1,373,455	1,030,089
Furniture	30	1,303,301	977,474	33	1,050,052	805,413
Paper	6	798,973	454,641	4	114,100	85,575
Primary metals (ferrous)	6	572,809	198,343	–	–	–
Primary metals (nonferrous)	2	235,700	176,775	2	327,657	228,908
Metal fabricating	38	3,390,004	2,435,618	30	3,506,568	2,388,084
Machinery	103	13,714,188	9,577,134	123	81,044,895	39,683,913
Aircraft and parts	3	454,720	341,040	4	265,833	209,375
Other transport and equipment	32	73,975,948	38,302,260	30	7,009,039	4,420,327
Electrical products	109	39,907,300	26,059,855	153	173,754,923	56,085,979
Mineral products	8	946,947	624,044	11	2,475,115	1,822,760
Petroleum products	–	–	–	2	271,614	184,960
Drugs and medicines	2	286,008	214,506	5	1,038,316	778,736
Other chemical products	13	5,135,238	2,668,641	15	5,290,475	3,006,789
Scientific instruments	13	6,821,564	3,616,171	5	2,039,746	1,204,684
Other manufacturing	40	2,493,776	1,871,329	69	5,515,356	4,067,397
Nonmanufacturing	2	193,611	145,208	2	482,120	361,590
Total	549	166,402,957	98,200,254	576	290,198,351	119,157,825

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-7

Enterprise Development Program: Contribution Project Approvals, by Provincial Location of Company Head Office, Fiscal Years 1977/78 through 1981/82

	1977/78			1978/79			1979/80			1980/81			1981/82		
	Number of projects	Amount	Distribution	Number of projects	Amount	Distribution	Number of projects	Amount	Distribution	Number of projects	Amount	Distribution	Number of projects	Amount	Distribution
		($ Thousands)	(Per cent)		($ Thousands)	(Per cent)		($ Thousands)	(Per cent)		($ Thousands)	(Per cent)		($ Thousands)	(Per cent)
Newfoundland	2	22	--	6	301	1	8	617	1	2	50	--	3	517	--
Prince Edward Island	2	95	1	5	167	--	7	422	1	6	387	1	4	421	--
Nova Scotia	2	15	--	5	90	--	15	1,332	2	15	1,107	1	15	679	--
New Brunswick	2	55	--	9	468	1	7	106	--	6	305	--	4	352	--
Quebec	67	3,221	18	92	4,688	12	176	13,770	16	250	47,943	49	306	35,202	30
Ontario	68	12,143	68	105	21,689	55	118	59,544	71	154	36,850	38	135	62,662	54
Manitoba	13	587	3	14	942	2	29	1,420	2	25	1,998	2	33	9,534	8
Saskatchewan	5	180	1	11	495	1	13	1,096	1	18	1,106	1	10	1,320	1
Alberta	15	560	3	20	1,815	5	35	1,890	2	34	3,115	3	32	3,685	3
British Columbia	19	1,122	6	17	8,934	23	33	3,833	4	39	5,339	5	34	4,725	4
Total	195	18,000	100	284	39,589	100	441	84,031	100	549	98,200	100	576	119,158	100

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-8

Enterprise Development Program: Contribution Project Approvals, by Company Size (Sales), Fiscal Years 1977/78 through 1981/82

	1977/78		1978/79		1979/80		1980/81		1981/82	
	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Company size, based on sales ($ thousands):										
Less than 5,000	162	9,122	221	17,654	385	50,476	489	50,450	506	43,823
5,000 to 24,999	28	2,369	55	19,739	48	29,844	51	16,949	41	32,644
Over 25,000	5	6,509	9	6,196	10	4,298	9	30,801	29	42,691
Total	195	18,000	285	43,859	443	84,618	549	98,200	576	119,158

SOURCE: Based on data from the Department of Industry, Trade and Commerce.

Table D-9

Enterprise Development Program: Contribution Project Approvals, by Nationality of Company Ownership, Fiscal Years 1977/78 through 1981/82

	1977/78		1978/79		1979/80		1980/81		1981/82	
	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount	Number of projects	Amount
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Nationality of company ownership:										
Canadian-owned	188	10,573	273	41,621	425	76,403	534	89,062	558	80,369
U.S.-owned	6	6,677	9	1,683	11	2,685	13	7,947	12	24,365
Other foreign-owned	1	750	3	285	7	5,529	2	1,191	6	14,424
Total	195	18,000	285	43,589	443	84,617	549	98,200	576	119,158

SOURCE: Based on data from the Department of Industry, Trade and Commerce.

Table D-10

Defence Industry Productivity Program: Expenditures, by Program Component, Fiscal Years 1968/69 through 1978/79

	Projects		Expenditures		
	Number	Distribution	Amount	Distribution	Average value
		(Per cent)	($ Millions)	(Per cent)	($ Thousands)
Program component:					
Research and development	199	32.9	292.8	69.0	1,471
Capital assistance	291	48.2	52.0	12.3	179
Source establishment	114	18.9	79.5	18.7	697
Total	604	100.0	424.3	100.0	702

SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-11

Defence Industry Productivity Program: Expenditures, by Program Component and by Industry Group, Fiscal Years 1968/69 through 1978/79

	Capital assistance		Source establishment		R&D		Total	
	Number of projects	Total subsidies	Number of projects	Total subsidies	Number of projects	Total subsidies	Number of projects	Total subsidies
		($ Thousands)		($ Thousands)		($ Thousands)		($ Thousands)
Industry group:								
Chemicals	8	878	3	7,692	–	–	11	8,570
Electrical and electronics	74	12,620	42	8,251	131	96,104	247	116,975
Machinery	33	4,438	5	241	3	3,194	41	7,873
Resource industries	9	1,248	4	386	1	627	14	2,261
Transportation industries[1]	163	32,552	59	62,780	62	190,978	284	286,310
Textile and consumer products	4	312	–	–	–	–	4	312
Defence programs	–	–	–	–	1	829	1	829
Indeterminate	–	–	1	109	1	1,029	2	1,138
All groups	291	52,049	114	79,459	199	292,762	604	424,270
				(Per cent)				
Distribution:								
Chemicals	72.7	10.2	27.3	89.8	–	–	100.0	100.0
Electrical and electronics	30.0	10.8	17.0	7.1	53.0	82.2	100.0	100.0
Machinery	80.5	56.4	12.2	3.1	7.3	40.6	100.0	100.0
Resource industries	64.3	55.2	28.6	17.1	7.1	27.7	100.0	100.0
Transportation industries[1]	57.4	11.4	20.8	21.9	21.8	66.7	100.0	100.0
Textile and consumer products	100.0	100.0	–	–	–	–	100.0	100.0
Defence programs	–	–	–	–	100.0	100.0	100.0	100.0
Indeterminate	–	–	50.0	9.6	50.0	90.4	100.0	100.0
All groups	48.2	12.3	18.9	18.7	32.9	69.0	100.0	100.0

1 Primarily, but not exclusively, aerospace.
SOURCE Based on data from the Department of Industry, Trade and Commerce.

Table D-12

Industrial Research Assistance Program: Expenditures, by Industry Group, Fiscal Years 1962/63 through 1981/82

	1962/63		1963/64		1964/65		1965/66		1966/67		1967/68		1968/69	
	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)
Food	52.4	9.7	190.9	11.9	226.5	10.4	314.1	9.5	373.5	8.9	511.6	10.1	554.2	9.1
Rubber	24.9	4.6	80.4	5.0	137.5	6.3	236.9	7.2	398.7	9.5	510.0	10.0	556.1	9.1
Textiles	5.8	1.1	15.9	1.0	83.4	1.5	80.3	2.4	89.2	2.1	53.1	1.1	101.4	1.7
Wood	0.0	0.0	26.1	1.6	99.1	4.6	153.2	4.6	187.5	4.5	205.9	4.0	212.7	3.5
Paper	42.8	8.0	93.3	5.8	123.5	5.7	172.7	5.2	329.0	7.8	543.4	10.7	672.0	11.0
Primary metals	40.0	7.4	128.5	8.0	224.7	10.3	243.8	7.4	198.9	4.7	275.1	5.4	275.3	4.6
Metal fabricating	31.1	5.8	50.9	3.2	78.1	3.6	16.2	0.5	0.0	0.0	48.0	0.9	96.2	1.6
Machinery	24.3	4.5	65.2	4.1	77.5	3.6	144.1	4.4	270.2	6.4	295.7	5.8	295.9	4.8
Transportation	0.0	0.0	20.5	1.3	25.8	1.2	35.9	1.1	0.0	0.0	0.0	0.0	51.1	0.8
Electronics	91.4	17.0	258.2	16.1	310.6	14.3	483.4	14.5	553.7	13.2	566.7	11.2	762.6	12.5
Nonmetal mining	20.7	3.9	88.3	5.5	95.9	4.4	107.5	3.3	231.3	5.5	322.8	6.3	342.6	5.6
Petroleum	79.4	14.9	160.5	10.0	101.0	4.7	144.2	4.4	122.1	2.9	108.6	2.1	143.4	2.3
Chemicals	69.2	12.9	197.5	12.4	290.9	13.4	654.9	19.8	812.7	19.4	902.5	17.8	1,108.4	18.1
Pharmaceuticals	42.0	7.8	190.9	11.9	288.3	13.3	401.8	12.2	528.0	12.6	637.3	12.5	796.2	13.0
Other	12.8	2.4	36.0	2.2	58.5	2.7	117.3	3.5	104.2	2.5	106.1	2.1	143.2	2.3
Total	537.3	100.0	1,603.6	100.0	2,171.3	100.0	3,306.3	100.0	4,199.0	100.0	5,086.8	100.0	6,111.3	100.0

	1969/70		1970/71		1971/72		1972/73		1973/74		1974/75		1975/76	
	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)	Amount ($ Thousands)	Distribution (Per cent)
Food	474.1	7.5	445.3	6.5	510.6	6.0	764.7	7.3	973.3	8.2	1,883	13.7	2,542	18.0
Rubber	602.8	9.6	581.0	8.5	444.0	5.2	429.0	4.1	450.2	3.8	458	3.3	372	2.6
Textiles	150.0	2.4	232.4	3.4	275.7	3.2	278.3	2.7	278.1	2.3	97	0.7	61	0.4
Wood	106.7	1.7	20.3	0.3	49.5	0.6	81.0	0.8	93.0	0.7	128	0.9	142	1.0
Paper	742.1	11.9	760.8	11.1	1,098.7	12.9	1,344.2	12.9	1,130.0	9.5	992	7.2	714	5.1
Primary metals	293.5	4.7	284.0	4.2	352.2	4.1	551.5	5.3	803.2	6.7	1,065	7.7	1,205	8.6
Metal fabricating	112.4	1.8	138.4	2.0	120.9	1.4	61.4	0.6	173.5	1.4	208	1.5	237	1.7
Machinery	339.3	5.4	344.7	5.0	566.5	6.6	706.4	6.8	667.4	5.6	635	4.6	801	5.7
Transportation	81.4	1.3	163.8	1.5	175.8	2.1	273.3	2.6	294.2	2.5	271	2.0	260	1.9
Electronics	814.3	12.9	1,075.7	15.7	1,316.2	15.4	1,844.1	17.7	2,707.9	22.7	3,255	23.6	3,166	22.5
Nonmetal mining	285.6	4.5	237.6	3.5	285.9	3.3	361.5	3.5	412.9	3.5	280	2.0	308	2.2
Petroleum	171.2	2.7	119.6	1.7	183.1	2.2	180.6	1.7	309.4	2.6	437	3.2	399	2.8
Chemicals	1,234.1	19.5	1,552.0	22.6	1,902.8	22.3	2,070.7	19.9	1,956.8	16.4	2,055	14.9	1,768	12.5
Pharmaceuticals	663.0	10.5	672.2	9.8	702.8	8.2	727.0	6.9	811.2	6.8	893	6.5	879	6.2
Other	224.6	3.6	288.2	4.2	558.1	6.5	747.1	7.2	875.0	7.3	1,130	8.2	1,238	8.8
Total	6,295.1	100.0	6,855.7	100.0	8,542.8	100.0	10,421.3	100.0	11,936.1	100.0	13,787	100.0	14,093	100.0

Table D-12 (concl'd.)

	1976/77		1977/78		1978/79		1979/80		1980/81		1981/82	
	Amount	Distri-bution	Amount	Distri-bution	Amount	Distri-bution	Amount	Distri-bution	Amount	Distri-bution	Amount	Distri-bution
	($ Thou-sands)	(Per cent)	($ Thou-sands)	(Per cent)	($ Thou-sands)	(Per cent)	($ Thou-sands)	(Per cent)	($ Thou-sands)	(Per cent)	($ Thou-sands)	(Per cent)
Food	2,806	19.3	3,201	20.8	3,955	22.0	4,696	24.0	4,648	22.5	5,158	21.5
Rubber	469	3.2	440	2.9	627	3.5	619	3.2	501	2.4	573	2.4
Textiles	60	0.4	65	0.4	71	0.4	42	0.2	47	0.2	115	0.5
Wood	80	0.6	–	–	18	0.1	70	0.4	59	0.3	39	0.2
Paper	743	5.1	786	5.1	765	4.3	777	4.0	898	4.3	710	3.0
Primary metals	1,385	9.5	989	6.4	748	4.2	649	3.3	642	3.1	637	2.7
Metal fabricating	185	1.3	236	1.5	411	2.3	617	3.2	974	4.7	1,298	5.4
Machinery	945	6.5	1,185	7.7	1,365	7.6	1,458	7.5	1,247	6.0	1,931	8.1
Transportation	268	1.9	341	2.2	454	2.5	553	2.7	489	2.4	671	2.8
Electronics	3,371	23.2	3,930	25.5	5,072	28.2	5,073	25.9	5,796	28.0	6,969	29.0
Nonmetal mining	277	1.9	190	1.2	341	1.9	369	1.9	302	1.5	343	1.4
Petroleum	253	1.7	258	1.7	152	0.8	67	0.3	12	0.1	3	–
Chemicals	1,566	10.8	1,650	10.7	1,666	9.3	1,968	10.1	2,489	12.0	2,479	10.4
Pharmaceuticals	875	6.0	870	5.7	846	4.7	1,327	6.8	1,330	6.4	1,311	5.5
Other	1,235	8.5	1,253	8.1	1,487	8.3	1,260	6.5	1,255	6.1	1,699	7.1
Total	14,518	100.0	15,394	100.0	17,977	100.0	19,515	100.0	20,691	100.0	23,935	100.0

SOURCE Based on data from the National Research Council of Canada.

Table D-13

Industrial Research Assistance Program: Expenditures, by Nationality of Company Ownership and by Company Size, Fiscal Years 1962/63 through 1981/82

	1962/63		1963/64		1964/65		1965/66		1966/67		1967/68		1968/69	
	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)
Nationality of company ownership:														
Canadian	163.9	31.0	495.2	31.0	656.8	30.0	962.5	29.0	1,285.6	31.0	1,634.8	32.0	2,296.1	38.0
Foreign	373.4	69.0	1,108.4	69.0	1,514.5	70.0	2,343.8	71.0	2,913.4	39.0	3,452.0	68.0	3,815.2	62.0
Company size:														
Small	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Medium	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Large	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Associations	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total	537.3	100.0	1,603.6	100.0	2,171.3	100.0	3,306.3	100.0	4,199.0	100.0	5,086.8	100.0	6,111.3	100.0

	1969/70		1970/71		1971/72		1972/73		1973/74		1974/75	
	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	Per cent)	($ Thousands)	(Per cent)
Nationality of company ownership:												
Canadian	2,645.3	42.0	3,129.2	45.6	4,869.4	57.0	6,578.1	63.1	8,210.4	68.8	9,774	70.9
Foreign	3,649.8	58.0	3,726.5	54.4	3,673.4	43.0	3,843.2	36.9	3,725.3	31.2	4,012	29.1
Company size:												
Small	1,349.9	21.4	1,896.5	27.7	2,971.0	34.8	3,906.6	37.5	4,487.2	37.6	5,483	39.8
Medium	1,261.3	20.0	1,285.4	18.7	1,490.3	17.4	1,718.3	16.5	1,761.3	14.8	1,982	14.4
Large	3,428.6	54.5	3,481.0	50.8	3,678.2	43.1	4,217.6	40.4	5,024.3	42.0	5,533	40.1
Associations	255.3	4.1	192.8	2.8	403.3	4.7	578.8	5.6	663.1	5.6	788	5.7
Total	6,295.1	100.0	6,855.7	100.0	8,542.8	100.0	10,421.3	100.0	11,936.1	100.0	3,786	100.0

Table D-13 (concl'd.)

	1975/76		1976/77		1977/78		1978/79		1979/80		1980/81		1981/82	
	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution	Amount	Distribution
	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($ Thousands)	(Per cent)	($Thousands)	(Per cent)	($ Thousands)	(Per cent)
Nationality of company ownership:														
Canadian	10,009	71.0	9,728	67.0	10,600	68.9	12,921	71.9	14,464	74.1	15,947	77.1	18,274	76.3
Foreign	4,084	29.0	4,790	33.0	4,795	31.1	5,056	28.1	5,051	25.9	4,744	22.9	5,661	23.7
Company size:														
Small	5,133	36.4	5,271	36.3	6,615	43.0	8,983	50.0	9,945	51.0	11,288	54.6	13,285	55.5
Medium	2,284	16.2	2,499	17.2	2,598	16.9	2,551	14.2	3,082	15.8	3,062	14.8	4,077	17.0
Large	5,951	42.2	6,118	42.1	5,652	36.7	5,833	32.4	5,865	30.1	5,690	27.5	6,136	25.6
Associations	725	5.1	630	4.3	529	3.4	610	3.4	623	3.2	641	3.1	437	1.8
Total	14,093	100.0	14,518	100.0	15,394	100.0	17,977	100.0	19,515	100.0	20,691	100.0	23,935	100.0

SOURCE Based on data from the National Research Council of Canada.

Table D-14

Program for Industry/Laboratory Projects: Expenditures, Fiscal Years 1975/76 through 1981/82

	PILP expenditures
	($ Thousands)
1975/76	770
1976/77	2,084
1977/78	4,438
1978/79	5,988
1979/80	6,003
1980/81	8,882
1981/82	15,000

SOURCE Based on data from the National Research Council of Canada

Table D-15

Technical Information Service: Budget Allocations, Fiscal Years 1977/78 through 1979/80

	Budget allocations		
	1977/78	1978/79	1979/80
	($ Thousands)		
Paylist	1,308	1,404	1,502
Nonpaylist[1]	852	1,080	1,155
Total	2,160	2,484	2,657
Contributions[2]	-	250[3]	750
Total	2,160	2,734	3,407
Minor capital	10	10	10
Person-years	55	55	55

1 Includes the cost of contracts with provincial research organizations to provide TIS assistance in six provinces and that of a research contract with the Saskatchewan Research Council.
2 Contributions under the Science and Engineering Student Program (SESP) extend TIS assistance to senior students undertaking short-term projects in industry.
3 SESP got under way in October 1978; however, because students were unavailable or already committed under co-op programs, only about half of the 1978/79 allocation was spent, leaving a balance of about $123,000.

SOURCE Based on data from the National Research Council of Canada.

Notes

INTRODUCTION

1 This department began undergoing an extensive reorganization during the latter stages of the writing of this study. It is therefore entirely possible that, by the time the study sees the light of day, not only will the department have a different name, but both of its programs reviewed herein will be substantially transformed.

CHAPTER 1

1 McFetridge formulates his model in terms of a world in which the future is known with certainty. The same analytical results can, however, be obtained for a world characterized by uncertainty, by assuming that all relations are specified in risk-adjusted terms. The latter approach is adopted here.

2 The implications of the situation depicted in Figure 1-1 would have to be modified to the extent that X is exported or if the innovative firm were wholly or partly owned by foreigners; but these considerations are disregarded at this stage.

3 It has been suggested that these officials, who do not personally receive the benefits of the R&D, will find it more conducive to their own interests to exhaust rather than maximize net social benefits. See Hettich (1975) and references cited therein.

4 In line with the preceding argument, B approaches the optimal total benefits (W in Equation (1)) when T approaches zero. When T approaches infinity, B approaches G, and both fall short of W by the present value of the lost consumers' surplus.

5 This discussion naturally involves the relaxation of an earlier assumption – that all subsidized firms are Canadian-owned. The companion assumption – that the product is not exported – is, however, retained. The implications of an exported product are discussed elsewhere.

6 A personal income tax is, of course, not the only means by which the government could finance the subsidy. Apart from the other forms of taxes that it could impose, the government could finance the subsidy by means of inflation. To couch the discussion in terms of other sources of finance would only serve, however, to make it much more complex than is necessary for present purposes.

7 The costs of collecting the necessary taxes should, in principle, also be considered. The fact is, however, that these taxes have always represented a very minor proportion of the total personal income taxes levied – a situation that is unlikely to change in the foreseeable future. It is thus reasonable to assume that the marginal collection costs involved are negligible – all the more so since the *raison d'être* of the personal income tax system can hardly be attributed to the need to finance the various subsidy programs of the federal government. Usher implicitly takes a different view, as he assigns to these programs estimates of the per-dollar-of-subsidy costs incurred by the Department of National Revenue and of Finance.

8 The compliance cost is estimated in average, rather than in marginal, terms. This estimate seems too high, because Usher assumes that accountants spend half their time on tax work. While they certainly spend a considerable portion of their time on tax-related work, it is highly probable that accountants spend a larger proportion of their time on the traditional accounting and auditing functions that are the basis of their profession. Usher's companion assumption that lawyers spend one-tenth of their time on tax work is probably more realistic; but that, too, seems on the high side.

9 This implicitly assumes that all of the components of the total cost of $81 have been distributed, together with the $100 subsidy, between saving and consumption. While this seems realistic enough in the case of the other components, it may be less so in the case of the costs incurred by the government in delivering the subsidy. These are services, such as justice or defence, that would otherwise have been provided. Being services, they are fully consumed when supplied.

10 As an example, using the marginal propensity to save and the level of costs (assumed to be constant in per-dollar terms) postulated in the text, any level of incrementality less than roughly 26 per cent would lower total savings and investment. The basic relation (neatly formulated by Usher) is as follows:

$$\begin{aligned}\Delta I &= mG - s\,[G(1+n) - G(1-m)] \\ &= [m - s(m+n)]\,G,\end{aligned}$$

where ΔI = increase in aggregate investment;

m = rate of incrementality to the firm and industry;
G = dollars of subsidy paid;
n = per dollar costs of tax-subsidy transfer, whereby G dollars was paid; and
s = marginal propensity to save.

11 It will be noticed that, although Mansfield *et al.*'s K is equivalent to McFetridge's $\hat{C}$, the denominator in K is P_2 (the new price), while that in $\hat{C}$ is P_1 (the old price). The latter denominator seems to be the correct one. Whether this makes much difference in specific situations is, of course, an empirical question. The chances are that it does not, in most cases, since Kn

will usually be very small. Much the same can be said of the fact that Mansfield *et al.*'s formulation involves Q_2 (the new quantity), whereas McFetridge's version involves Q_1 (the old quantity). Generally speaking, $(Q_2 - Q_1)$ is likely to be very small in the cases of the innovations subsidized under EDP, IRAP and PILP.

12 Expressing the relationship between the subsidy and the firm's own R&D spending in this fashion implicitly assumes that the two outlays occur more or less *pari passu*, usually in instalments. Generally speaking, this assumption seems to be reasonable with respect to the programs under review.

13 It might be mentioned parenthetically that there is one category of the social costs of a subsidized innovation that is not reckoned with in this study – namely, the losses to various economic agents adversely affected by its emergence. These would include, in the case of a new product, the costs to the producers of products rendered obsolete or redundant by it. It would also include, in the case of a new process, the costs to competitors of adapting existing processes. For there is no doubt that the emergence of the new destroys the old. It is, however, too much to expect program administrators to be able to accurately identify and measure these costs. Nor is it all that clear that an otherwise desirable innovation should not go forward because of them, if only on the grounds that the gainers might be able to more than compensate the losers along Hicks-Kaldor lines. It seems more sensible to take the view that the recognition of, and response to, the traumas of technological advance should, when they are serious enough, be included among the responsibilities of the formulators of macroeconomic and regional policies.

Chapter 2

1 Other programs were the General Adjustment Assistance Program (GAAP); the Automotive Manufacturing Assistance Program (AMAP); the Pharmaceutical Industry Development Assistance (PIDA); and the Industrial Design Assistance Program (IDAP).

2 This information was provided by senior administrators of the Program and is based upon internal, confidential documents that cannot be quoted directly.

3 Information pertaining to the collective thinking within the Department with respect to the significant-burden criterion was obtained in discussions with various senior officials of the Department and also from a perusal of numerous internal memoranda, etc. These were kindly made available, with permission to discuss their contents in a nonattributable fashion.

4 The present writer was permitted to attend a meeting of the Innovation Assistance Panel, at which decisions on a number of applications for smaller subsidies were reached. Although none of these cases is reported here, it can be said that the general comments made in regard to the six cases that were reported apply, on the whole, to these cases as well.

5 One has only to contemplate the plethora of objectives assigned to PAIT, for example, to appreciate this.

6 The financial data discussed above embody these estimates, either by themselves or together with other estimated aspects of the firms' projected operations and financial positions. Moreover, in interviews with senior officers of various firms in connection with a survey of other aspects of the innovative behaviour of firms, the present writer learned that it is common practice for firms to make such estimates before embarking on R&D projects of any significant order of magnitude. Indeed, these interviews confirm that if the Board explicitly required the kinds of information that were specified in this study as being necessary to ensure that subsidized projects stand a reasonable chance of being incremental to the firms involved, the firms would have little difficulty in furnishing them.

Chapter 3

1 Export subsidies are frowned upon for much the same reasons as tariffs on imports are. [A good example of the large literature on the subject is Pearce (1970)]. This basic view also disregards the type of argument developed, for example, in Jenkins (1977). The author estimates that the social value of foreign exchange earned by Canada is approximately 115 per cent of its market value. This could be taken to imply that exports bring an inherent benefit; and imports, an inherent cost and that, in turn, could serve as a broad rationale for subsidizing exports. It seems fair to say – without prejudice to an excellent and intriguing study – that much more research is necessary before the analytical model used therein can be accepted as having sufficient applicability to Canada's present and future position in the international market place to serve as a basis for policy.

2 Although they are obviously important, scale considerations are disregarded throughout, because our primary purpose is to establish the best focal point for a program such as DIPP and to merely identify some of the salient features associated with it. A proper analysis of the efficient administration of such a program would certainly include careful attention to the question of the appropriate scale of operations.

3 It should also be mentioned that this cursory discussion ignores the need to make the necessary calculations in inflation-adjusted terms and, in some cases, to focus upon divisions of firms rather than upon entire corporate entities. Neither of these considerations constitutes a serious practical problem.

4 The information upon which much of the discussion in this Part is based is contained in files and other documents in the possession of the DIPP administration, which were made available to the present writer. Other sections of the Department of Industry, Trade and Commerce also possess files pertaining to DIPP. These, however, were not sought for perusal, since the writer was assured that the DIPP files contained all significant information pertaining to the projects subsidized under the Program.

CHAPTER 4

1 There are indications that IRAP administrators are becoming much more conscious than before of the need to require applicant firms to provide them with a clear sense of the benefits that proposed projects can be expected to produce once they result in marketable products.

2 See, for example, Pavitt and Walker (1976), *passim*.

APPENDIX B

1 A recent, analogous study has also become available – namely, that of Hewitt. The methodology adopted in this paper does not seem entirely suitable for present purposes.

2 This last point implies that a two-equation model might be more appropriate. There is no doubt that the reduced-form specifications considered here are subject to distinct conceptual limitations. It does not, however, seem realistic to expect that subsidy program administrators will have the time or the resources to construct fully satisfactory, micro-level simultaneous-equation models. Hopefully, a version of the single-equation specifications will emerge, after some experimentation, as being capable of yielding reasonably reliable estimates of the impact of subsidies upon the own-R&D spending of the recipient firms.

3 The sample consists of 24 firms in the electrical products industry and 22 firms in the machinery and equipment industry (both industries having been defined by the Program). The interval is the four years between 1977 and 1980. All of the subsidies awarded were on the basis of decisions by the central Board, data on awards by regional Boards not being available. It might also be mentioned that, while McFetridge attempted to distinguish in some cases between domestically-owned and foreign-owned firms, by means of dummy variables, this distinction was not considered necessary in the present context. Finally, in an attempt to reduce heteroscedasticity, the dependent variable and all the explanatory variables were divided by S_{it}.

4 Note the lack of significance of the G1 variable with respect to both industries. For further evidence, see McFetridge.

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